Transportation Library

MAR 2 3 1960

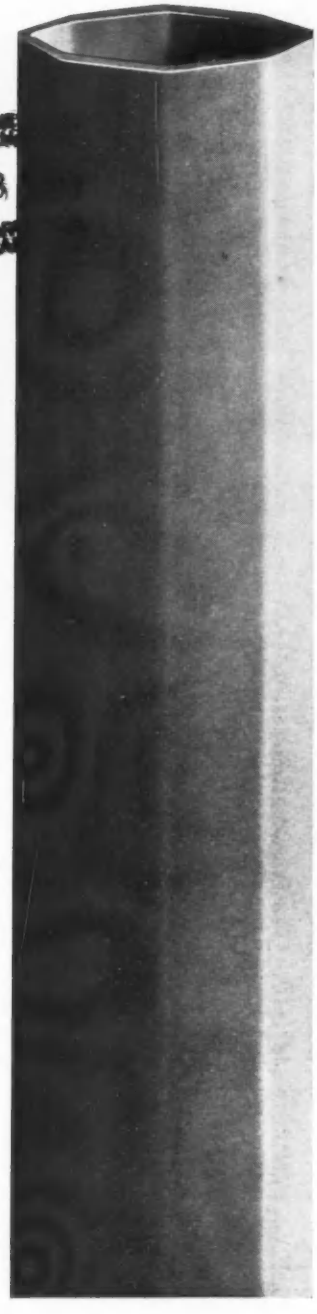

# The Dock & Harbour Authority

No. 472. Vol. XL | FEBRUARY, 1960 | Monthly 2s. 6d.


THE UNIVERSITY OF MICHIGAN
MAR 1


## Introducing the NEW

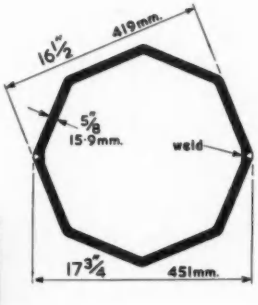
## FRODINGHAM OCTAGONAL BOX PILE



The New Frodingham Octagonal Steel Box Pile represents a major step forward in the design of steel bearing piles, as applied to the construction of permanent maritime structures such as piers, jetties, dolphins and quays.

The advantages of the new octagonal box pile over other existing types are derived from its regular eight-sided cross-section and from the uniform radius of gyration which gives the pile a notably high column strength.

The absence of projections at the weld results in a symmetrical pile which is ideally shaped for the easy attachment of bracing across any face of the octagon.




*Frodingham Octagonal Box Pile (Section 4) is fabricated from two identical rolled steel sections joined together as illustrated by continuous butt welding along the seams.*

*For full details write for List No. 206*

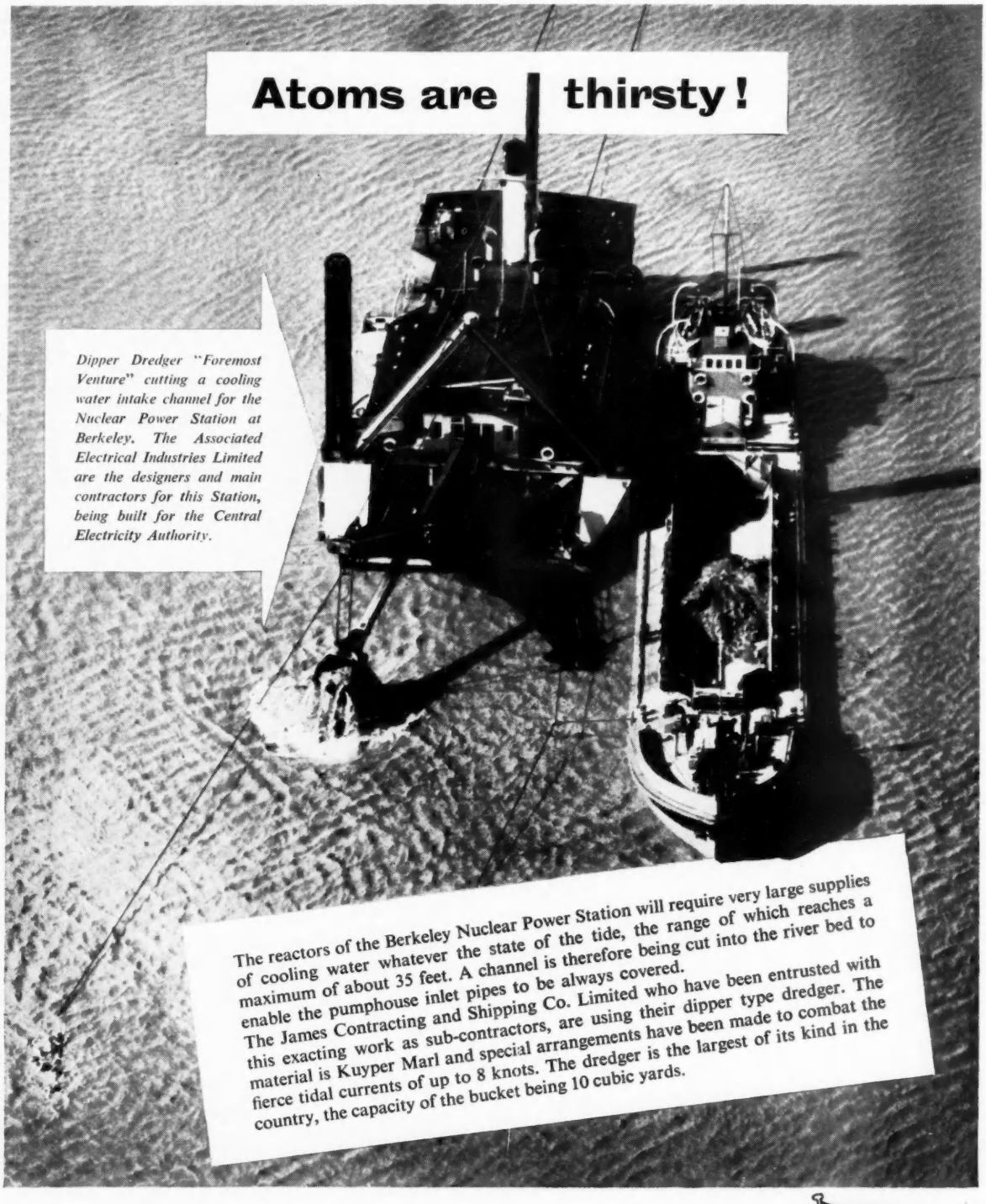
BSP

TECHNICAL REPRESENTATIVES THROUGHOUT THE WORLD

**THE BRITISH STEEL PILING CO. LTD.**

10 HAYMARKET, LONDON, S.W.1. *Telephone: TRAfalgar 1024*

# Atoms are thirsty!



*Dipper Dredger "Foremost Venture" cutting a cooling water intake channel for the Nuclear Power Station at Berkeley. The Associated Electrical Industries Limited are the designers and main contractors for this Station, being built for the Central Electricity Authority.*

The reactors of the Berkeley Nuclear Power Station will require very large supplies of cooling water whatever the state of the tide, the range of which reaches a maximum of about 35 feet. A channel is therefore being cut into the river bed to enable the pumphouse inlet pipes to be always covered.
The James Contracting and Shipping Co. Limited who have been entrusted with this exacting work as sub-contractors, are using their dipper type dredger. The material is Kuyper Marl and special arrangements have been made to combat the fierce tidal currents of up to 8 knots. The dredger is the largest of its kind in the country, the capacity of the bucket being 10 cubic yards.

James Contracting and Shipping Co. Ltd. are Contractors to Government and Harbour Authorities all over the world. They are owners of a large fleet of every kind of up-to-date Dredging Craft and are renowned for efficient, trouble-free service.

*Inquiries invited and estimates prepared free of charge for works in any part of the world.*

**JAMES**

**JAMES CONTRACTING AND SHIPPING CO. LTD.,**

**JAMES WHARF, SOUTHAMPTON.** Telephone: 22436/7 Telegrams: Towing, Southampton.

## To Correspondents

All Letters and Contributions intended for Publication should be addressed to the Editor :— K. R. Doggett, Assoc.I.C.E., and must in all cases be accompanied by the name and address of the sender.

## To Advertisers

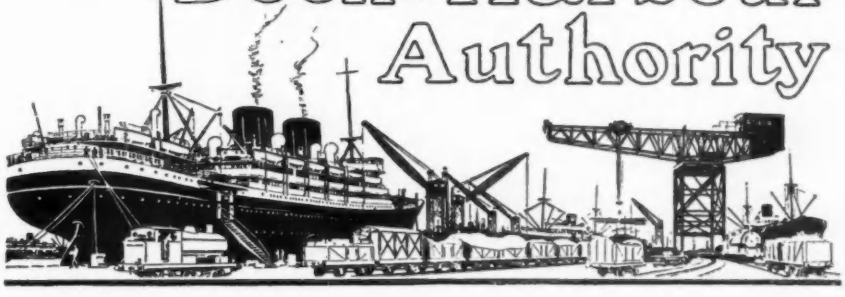
Our circulation is world-wide and we have subscribers in 85 countries. For Advertisement Rates and space particulars apply to the Advertisement Manager.

## Subscription Rates

PER 2s. 6d. COPY
(plus 8d. wrapping and postage).
Annual Subscription including postage :—
United Kingdom and Abroad
£1 18s. 0d.
U.S.A. and Canada
$6,00.
Back numbers (when available) are charged double if over 6 months old.
All subscriptions must be Prepaid. Postal Orders and Cheques should be made payable to: "The Dock and Harbour Authority," 19 Harcourt Street, London, W.1.

Telephone : PAD 0077 and 0078.


# The Dock & Harbour Authority



## CONTENTS


| | |
|---|---|
| EDITORIAL NOTES | 293 |
| THE PORT OF HOBART, TASMANIA | 295 |
| A MOVEMENT PREDICTION FOR USE WITH A SEA-WAVE RECORDER | 302 |
| MECHANICAL EQUIPMENT IN PORTS | 304 |
| NEW BULK WINE BERTH, LONDON DOCK | 309 |
| THE SURFACING OF WHARVES AND ROADS IN DOCK AREAS | 311 |
| OBITUARY AND RETIREMENT | 316 |
| THE CHANNEL TUNNEL PROJECT | 317 |
| THE DOCK AND HARBOUR AUTHORITIES' ASSOCIATION ANNUAL REPORT | 321 |
| CORRESPONDENCE | 323 |
| MANUFACTURERS' ANNOUNCEMENTS | 324 |



THE *NEW* NAME
TO REMEMBER IN DREDGING

SIMONS - LOBNITZ

When two famous Clydeside dredge builders combine their resources, the result for the customer is better delivery and keener prices. Integration meets the modern need and the amalgamation of Simons and Lobnitz at Renfrew, effective from 1st January 1960, offers a wealth of experience and technical ingenuity to shipowners and harbour authorities throughout the world.

SUCTION DREDGES
MULTI-BUCKET DREDGES
DIPPER DREDGES
GRAB DREDGES
ALLUVIAL DREDGES
HOPPER BARGES
ROCK BREAKERS
DREDGING MACHINERY INSTALLATIONS
FISH FACTORY SHIPS
HARBOUR CRAFT OF EVERY DESCRIPTION

SIMONS-LOBNITZ LTD · RENFREW · SCOTLAND Tel: RENfrew 3751

*Known over* *the World*

**Leith Western Extension Works—Breakwater under construction in 1940**

Leith was the first port in the United Kingdom to use this method of building breakwaters and experience has fully justified the claims that were made for this type of construction including the saving in initial cost and freedom from maintenance. The work was put in hand in 1936 and completed (not without difficulty) during the war, in 1942.

*Harbour Works Contractors*

*Dredging and Reclamation Specialists*

**CONTRACTORS TO THE ADMIRALTY, CROWN AGENTS, ETC.**

**K. L. KALIS**

SONS AND COMPANY LIMITED

**STONE HOUSE, BISHOPSGATE, LONDON, E.C.2**

TELEPHONE: BISHOPSGATE 7265 (3 LINES) TELEGRAMS: "SOUNDINGS, PHONE, LONDON"

The Dock & Harbour Authority

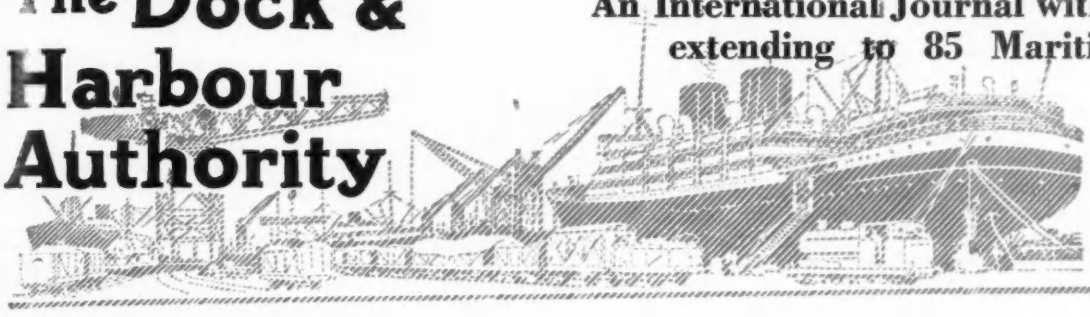
An International Journal with a circulation extending to 85 Maritime Countries

No. 472

Vol. XL

FEBRUARY, 1960

Monthly 2s. 6d.



# Editorial Notes

### The Port of Hobart

We are printing in this issue an interesting description of the Port of Hobart and of the plans which the Marine Board of Hobart have for the improvement and development of facilities which the economic growth of Tasmania may well require.

Like its sister port Burnie, on the opposite side of the island, Hobart is blessed with many natural advantages. The Derwent estuary provides extensive sheltered water able to accommodate the largest vessels afloat with virtually no problems of conservancy or navigation—recent callers included *Ile de France* and *U.S.S. Saratoga*—and though the configuration of the shore has its attendant difficulties when designing wharf installations, these are being overcome in a particularly elegant and effective way. In such circumstances the quay structure must rest on long unbraced piles pitched on to a cill of rock where there can be no lateral support; there is no problem of foundation as such, rather is it one of providing adequate lateral stability against berthing forces, which are resisted by header beams made monolithic with the deck. The nearer these forces can be brought to the level of the pile heads, the more efficient and economical the structure can become. The availability of larger-diameter tubular rubber fenders has enabled a simple fender system to be devised which, thanks to the small tidal range, can be equally effective against lighters, hoppers and harbour craft which are frequently more punishing to open-work structures than are ocean vessels.

The Port of Hobart has passed through the different stages of timber construction, orthodox reinforced concrete and the use of what amounts to a new material—prestressed concrete—in a relatively short time. The engineers are to be congratulated on the progress they have made in the new technique here being used so sensibly and effectively. The advantages of prestressed concrete, particularly in marine works, are manifold as the paper so clearly demonstrates. It is worthy of mention also that the floating bridge referred to in the paper will shortly be replaced by a high-level viaduct some 4,500-ft. long where an advanced technique of prestressed and post-stressed concrete will be employed in one of the most remarkable bridging projects now on foot.

The lay-out of the wharf facilities envisaged by the development plan (presumably to be introduced in stages as and when the need for them arises) is compact and good, both as regards the marginal quays and the wide pier quays. Macquarie No. 2 with its wide apron is particularly effective, for there is nothing to be gained by a narrow apron and much to be lost. Macquarie No. 1 though of later construction has not afforded the same opportunity for reasons which are obvious. The 150-ft. clear span shed at No. 2 will surely be the envy of most authorities. Without making a fetish of unobstructed floors, hitherto a span of 120-ft. has been regarded as about the economic limit for a pitched roof.

Traffic arrivals at Hobart in the last recorded year amounted to 471 vessels having an aggregate tonnage of 1,877,000 GRT and cargo handled, including that at several privately owned jetties outside harbour limits, was about 1,283,000 tons. The ultimate development plan seems to envisage some 10-12,000 linear feet of quayage. Hydro-electric resources in Tasmania have led to considerable development of secondary industries, notably zinc smelting, calcium carbide and newsprint, and primary products are becoming increasingly valuable. The Derwent estuary offers great scope for development and it is essential, and a true criterion of efficient administration that the publicly-owned facilities provided shall be fully utilised.

### The Channel Tunnel Project

In view of its topical interest, we are publishing on a following page in this issue an account of the sea bed investigations which were carried out in the English Channel last year in connection with the Channel Tunnel Project.

Since early in the 19th Century various interests in France and the United Kingdom have advocated the construction of a tunnel under the English Channel but, due to various economic and political factors, the scheme has not progressed during the ensuing 150 years beyond the building of two short pilot tunnels in 1882.

Interest in the scheme revived between the two World Wars and in 1930 the project was debated in the House of Commons and was defeated by the narrow margin of 179 votes against 172. In the last two years official and public opinion has moved still more in favour of the project. According to recent reports in the press, a number of Government departments have put in submissions favouring the project and the French Government, too, is believed to be well disposed towards the scheme.

The approval of the two Governments is essential to the success of the project because without political backing and probably some form of Government guarantee with regard to finance, there may be difficulty in finding the necessary capital for the construction of the tunnel—estimated to cost some £120 million. Last year the Channel Tunnel Study Group, which is composed of the Suez Finance Company, the U.K. Channel Tunnel Company, the French group in which the French State Railways is the major partner and Technical Studies, Inc., invited international tenders for an investigation of sea bed conditions in the Straits of Dover. The report of the investigation has now been pub-

lished and submitted to the Study Group for approval. It states that the Channel Tunnel project is feasible both technically and economically and confirms that it is not beyond modern engineering resources. For advocates of the Tunnel, this must be a welcome statement.

However, there remain considerable arguments against the scheme. Air transport developments such as the Rotodyne and the projected fast Hovercraft cross-Channel ferry might well attract much of the traffic previously expected to use the Tunnel. Again, the idea of a bridge has often been considered but this alternative plan, chiefly because of the great cost of constructing piers in mid-channel, maintenance costs and interference to navigation, is not considered a feasible alternative. In spite of its high cost and the many problems involved, the idea of a Channel Tunnel appears nearer realisation than it has ever been.

**The Problem of Flag Discrimination**

When the word " retaliation " is mentioned by a Government spokesman with regard to flag discrimination, it is evident that the authorities are now gravely concerned at practices which are hitting unfairly at British shipping. It is true that only the merest hint that such measures might be contemplated was given by Lord Chesham in the recent House of Lords debate on shipping, but he is a joint Parliamentary Secretary to the Ministry of Transport and presumably would not have spoken without due consideration. Lord Teynham, who initiated the debate, was emphatic on the issue. Whatever happens, he said, we could not be left behind in the maritime race and if other countries could not be persuaded to cease flag discrimination and the provision of heavy subsidies, we might be driven to do the same. Lord Chesham took up the point. He intimated that the Government certainly did not rule out the possibility that such measures might prove to be unavoidable—and he added that, in fact, the Government were considering this at the present time.

At this stage Lord Chesham became, justifiably, a little cautious. Before the Government could decide to adopt any policy of retaliation, he said, even in particular cases, they would need to consider very carefully, in conjunction with the shipping industry and with the Governments of other maritime countries who think as H.M. Government do, what the wider repercussions of any change of policy might be. Lord Chesham spoke of 74 formal protests having been made in the last ten years to 31 countries, besides informal representations. What successes had been secured could not be viewed against the " generally unfortunate background " of discrimination which continued to be practised by many countries.

This is the measure of the difficulty; in the " unfortunate background " stands the United States. It is putting it mildly to say that it would be " a great help " if this country could feel that we had greater support from the United States in the matter. They practise discrimination and take " other measures which are not very helpful to our shipping " ; and, unhappily their example is much too readily followed by other countries.

Retaliation is a dangerous weapon to employ, especially by a country whose shipping trades between foreign ports. But it has been shown, on occasion, to be useful. The U.S.A., by threatening counter-measures, secured the abolition by Ecuador of a discriminatory levy on cargo carried in non-Ecuadorian ships—a striking example of the way America is prepared to act when her own interests are involved, while at the same time upholding the right to exercise discrimation against others. Great Britain has many powerful guns in her armoury and no doubt could deploy this artillery very successfully in other spheres as well as shipping.

In any case, the hint has been given. The Government are looking into the matter and, however cautiously the announcement has been made, warning has been served on those foreign nations who treat British (and other) shipping unfavourably that they may have a rude awakening before long. There is no doubt that if Britain took a strong stand, those other countries who still look to her for leadership in maritime matters would follow suit. It could even be suggested that America herself is in a vulnerable position, although, as between Allies, reasoned argument is to be preferred to more aggressive tactics.

**National Fire Protection Conference**

The first National Fire Protection Conference, sponsored by the Fire Protection Association is being held in London on February 25 and 26. The Government will be represented by Mr. R. A. Butler, the Home Secretary, who is to address the Conference, and Mr. Edward Heath, the Minister of Labour, who will be the principal guest at the conference dinner on February 25.

Among the 850 people attending the meetings will be Home Office fire prevention experts, Ministry of Labour factory inspectors and public and industrial fire brigade officers from all over Britain. A number of representatives from the United States, Canada, France, Belgium, Sweden and Pakistan are also expected to attend.

The Fire Protection Association, which was established by the insurance companies as a national centre to formulate codes of practice for fire protection, includes among its 3,000 members many of the largest industrial concerns in Britain. It works in close co-operation with the Fire Research Station, which is operated jointly by the Department of Scientific and Industrial Research and the fire insurance companies.

The need for greater publicity and co-operation in fire prevention and fire fighting, is shown by the fact that, last year, there was an unfortunate record of fire damage—provisional estimates put the losses at over £40 million, mainly due to an unusual number of large factory fires.

One serious problem facing all concerned with fire prevention is the ease with which flames can spread through open-plan factories and warehouses which lack adequate fire breaks, and it surely should be to the advantage of all concerned that building plans should be submitted in advance to insurers with a view to reducing fire hazards.

The main purpose of the conference is to give support to the fire prevention measures in the Factories Act 1959 which is designed to set new standards of fire protection for industry. Part of the new Act is already in force, and the Fire Protection Association is prepared to give advice not only on matters affected by the law, but also on precautions which will not be covered by regulations but which are desirable in themselves.

**Institute of Transport Congress**

The 1960 Congress of the Institute of Transport is to be held in London on April 26—28 and will be opened by Mr. Ernest Marples, Minister of Transport.

Three papers on the future of transport will be read. Sir Brian Robertson, chairman of the British Transport Commission and a vice president of the Institute, will speak on " Some thoughts on the future of inland transport "; Sir Donald Anderson, chairman-elect of the Peninsular and Oriental Steam Navigation Company and a past president of the Chamber of Shipping of the United Kingdom, will give a paper on " British Shipping—a national service or a commercial enterprise?"; and Mr. Peter Masefield, past president of the Institute and managing director of Bristol Aircraft Ltd., is to speak on " British Transport Aeronautics—looking ahead ".

This will be the first time since 1925 that the congress is being held in London.

# The Port of Hobart, Tasmania

## Description of Reconstruction and Development Works

By A. L. STEED, Manager and Port Engineer.

THE Port of Hobart lies at the mouth of the Derwent River on the South East coast of Tasmania. The river was first navigated by white men in 1793 but it was not until 1804 that the deep water inlet known as Sullivans Cove, around which the port has developed, was discovered. Many of the early immigrants were persons convicted in England, some for quite minor crimes, and sentenced to deportation, so that convict labour was used extensively for the development of the port.

Though a stone jetty for the use of lighters was built off Hunter Island in 1822, wharf construction proper began only in 1830 with the first section of the New Wharf on the Southern side of the Cove, the precursor of today's Princes Wharf. By 1850 Hobart was a busy port, exporting timber, wool and grain with prosperous whaling and shipbuilding industries. In 1858 the Marine Board of Hobart was formed with jurisdiction over the East and South Coasts of Tasmania.

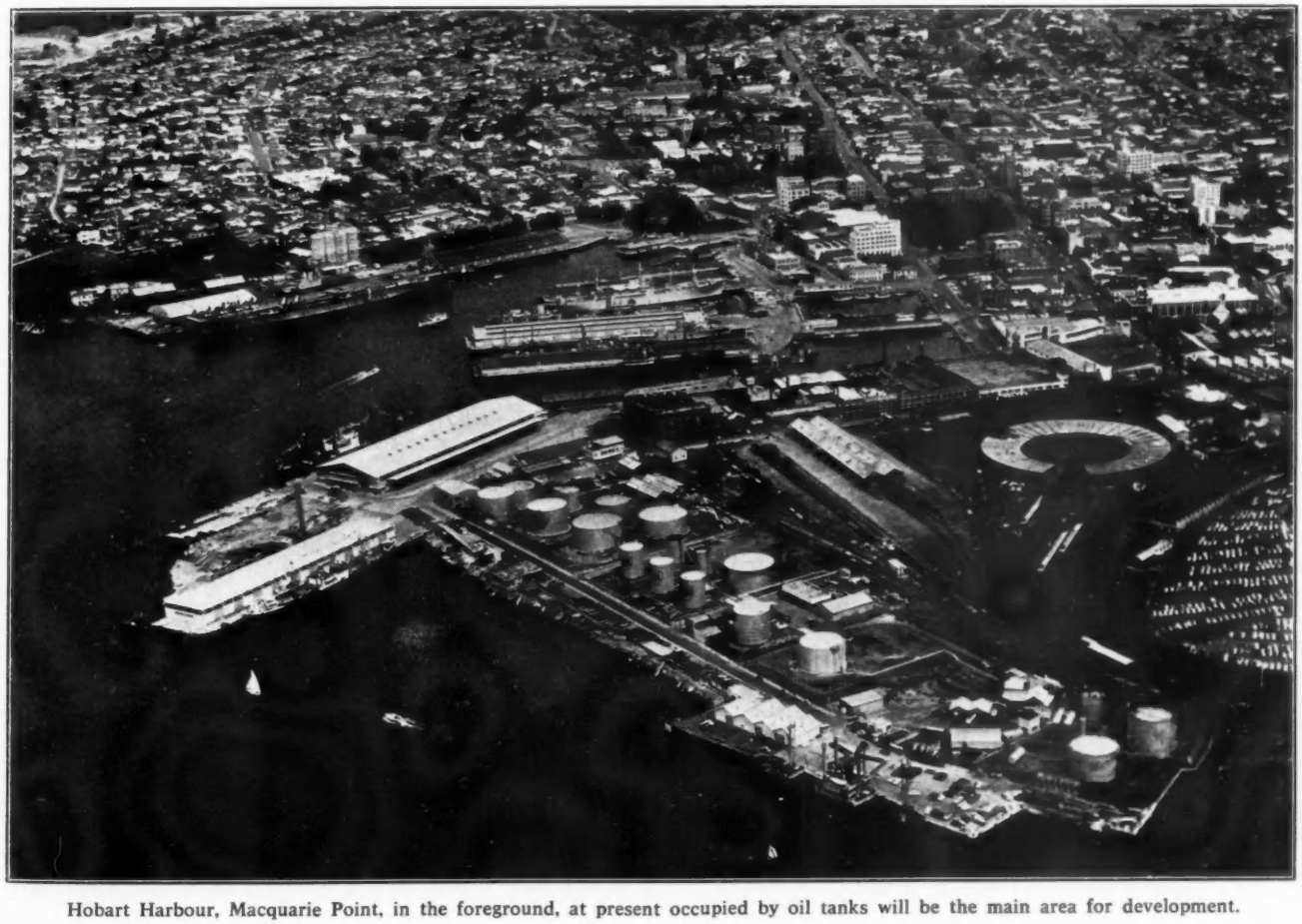
Extensive timber resources close to the town led to the construction of wharves and piers in this material, but it was found that Tasmanian hardwoods have poor resistance against the attack of insects such as Teredo, so that in spite of rebuilding and repairs only two of the old timber piers are now standing—Queens Pier and Kings Pier, built in 1901 and 1910 respectively, and both reconstructed extensively in 1946.

The outfall of the Hobart Rivulet on the Northern shore of the Cove restricted development Northwards until 1914, when work was commenced on the diversion of the rivulet to the North of Macquarie Point. Reclamation of a considerable area of land has now opened up the Point for future expansion.

### Harbour

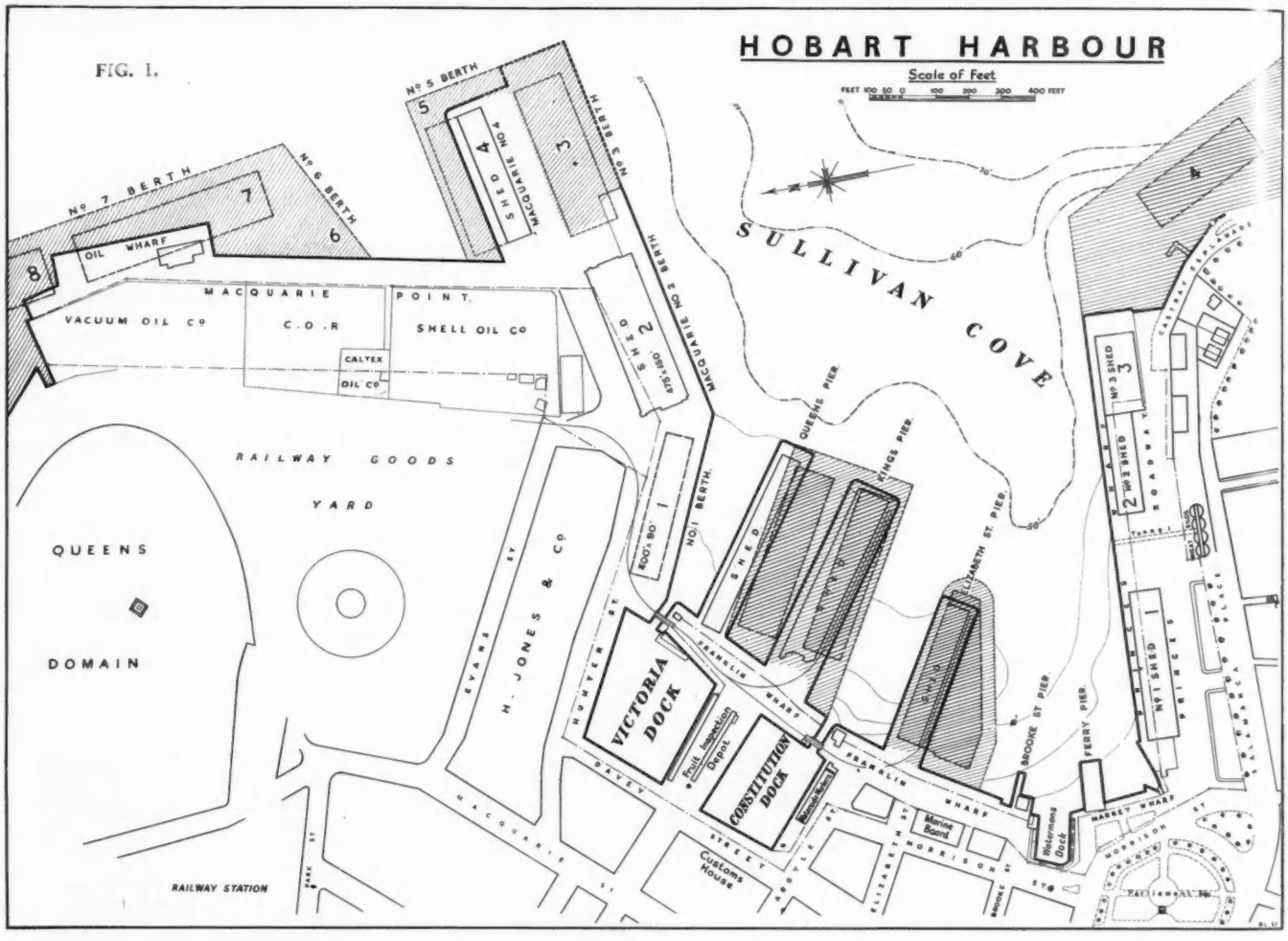
The river entrance, marked by Derwent Light, averages three miles in width and from 60 to 150-ft. in depth. At the Port, the river is approximately 1½ miles wide, and its depth varies from 60 to 100-ft., within a few hundred feet of the main wharfage area.

Approximately one mile upstream the River is spanned by a "Floating Arch" Highway Bridge, which has a lift span incorporated in its Western Abutment, allowshipping of up to 30-ft. draft to proceed a further three miles upstream to the Electrolytic Zinc Company of Australia works and wharf at Risdon. Between the Bridge and the Derwent Light there is an area of 20,000 acres of broad water which affords an ideal anchorage for the largest ships. There are no navigational hazards between the entrance to the River and the Bridge,



Hobart Harbour, Macquarie Point, in the foreground, at present occupied by oil tanks will be the main area for development.

FIG. 1.




and with a mean spring rise of only 4-ft. 6-in. the port has ideal conditions for open berthages.

Hobart is a clean, attractive port lying so close to the city that the wharves and piers merge with the city streets. Marginal type wharves flank each side of the cove with Queens, Kings and Elizabeth Street piers springing from Franklin Wharf. There is provision for tourist steamers and ferry boats at Brooke Street Pier and Ferry Pier.

The principal berths are shown in the table below.

These berths are general cargo berths and are used by both Interstate and Overseas vessels.

An Oil Wharf, situated just north of Ocean Pier with a berthing face of 500-ft. is used for the discharge of Petroleum products to the bulk storage installations of the various oil companies which are situated just behind the wharf. The wharf has recently been reconstructed with a concrete surface and is now also used for the discharge of steel cargoes. A Tanker Berth has been constructed at Selfs Point, about two miles upstream from the main port area, and oil installations are progressively being removed to this new location.

There are two docks—Victoria and Constitution—with a depth of about 10-ft. which are used by samll intra-state traders and sailing vessels. The cream of Australia's ocean-going yachts line up in Constitution Dock on completion of the annual Sydney-Hobart Yacht Race. A slipway of 800 tons capacity is situated just north of the main port area.

| Location | Length of Berth | Depth Alongside (L.W.) | Shed Dimensions |
|---|---|---|---|
| Princes Wharf | 1,300-ft. | 23-ft. to 39-ft. | (1) 450-ft. x 90-ft.<br>(2) 310-ft. x 80-ft.<br>(3) 240-ft. x 120-ft. |
| Elizabeth Street Pier | South 515-ft.<br>North 500-ft. | 21-ft. to 38-ft.<br>27-ft. to 45-ft. | 440-ft. x 70-ft. |
| Kings Pier | South 650-ft.<br>North 688-ft. | 30-ft. to 43-ft.<br>23-ft. to 43-ft. | 530-ft. x 100-ft. |
| Queens Pier | South 600-ft.<br>North 619-ft. | 20-ft. to 42-ft.<br>23-ft. to 40-ft. | 570-ft. x 60-ft. |
| Macquarie Wharf No. 1 | 600-ft. | 35-ft. to 25-ft. | 400-ft. x 90-ft. |
| No. 2 | 600-ft. | 32-ft. to 38-ft. | 475-ft. x 150-ft. |
| No. 3 | 225-ft. | 40-ft. to 90-ft. | (Part only constructed) |
| No. 4 | 500-ft. | 23-ft. to 46-ft. | 420-ft. x 80-ft. |

**Trade**

The port is busiest in the months of March to June when over four million bushels of apples and pears pass over the Wharves. A further 15,000 tons of fruit is exported annually in dried, preserved or pulped form. Newsprint brought to Hobart by lighter from the Australian Newsprint Mills at Boyer, 20 miles upstream, zinc products from the Electrolytic Zinc Works at Risdon, Wool, and general cargo bring up the total exports to 750,000 tons each year.

Annually about 500,000 tons of cargo, principally foodstuffs and manufactured goods, enter the port. Bulk-handling facilities are available for imports of wheat, ores and petroleum products but general cargo

wharves and piers serve all other commodities.

The Marine Board runs a Mechanical Equipment Pool of fork trucks, tow-motors, elevators and mobile cranes and 90% of the cargo is handled by these machines, which are operated by the Board's employees.

**Port Development**

The rapidity of attack of local timber by Teredo and consequent necessity for replacement of piers at frequent intervals led the Board in 1930 to the policy of replacement of timber piers by reinforced concrete. Elizabeth Street Pier and Princes Wharf were rebuilt as beam and slab structures on R.C. piles and have been practically free from maintenance although a limited amount of spalling has recently been encountered at the bottoms of beams which were deep, narrow and heavily reinforced.

Reconstruction work was halted at the outbreak of the war with the result that by 1946 the older timber piers had reached an advanced stage of decay, and the position was further aggravated by a disastrous fire that largely destroyed Ocean Pier, which had been the principal overseas berth, in 1948. The situation was met by the rehabilitation of Queens Pier and the reconstruction and widening of Kings Pier in timber. Further demands for more wharfage resulted in the construction of Macquarie Wharf No. 4 Berth in timber as a temporary measure; however, it was possible to proceed concurrently with new permanent construction in the form of Princes No. 3 Shed, with concrete walls and steel roof trusses having a clear span of 120-ft. This shed was opened in 1953.

The present proposals for development of the port are shown on the plan in Fig. 1. It has been estimated that the effective lives of Kings Pier and Queens Pier will not exceed 10 years, and these piers will be replaced by a single wide pier with two sheds, a central roadway and an open berth across the end. As the reconstruction of these piers will temporarily deprive the Port of the use of four berths the construction of additional berthage in the meantime is essential.

The principal extensions to the Port will be in the Macquarie Point area to the north of Sullivans Cove where eight new berths are projected. Work commenced on No. 2 Berth in 1952 and 50 reinforced concrete piles were driven. However, shortage of loan funds halted the work for three years. Work resumed in 1955, design, piling and road construction being carried out by the Board, while the deck structure and shed were constructed by contract. The Wharf was opened in May 1958.

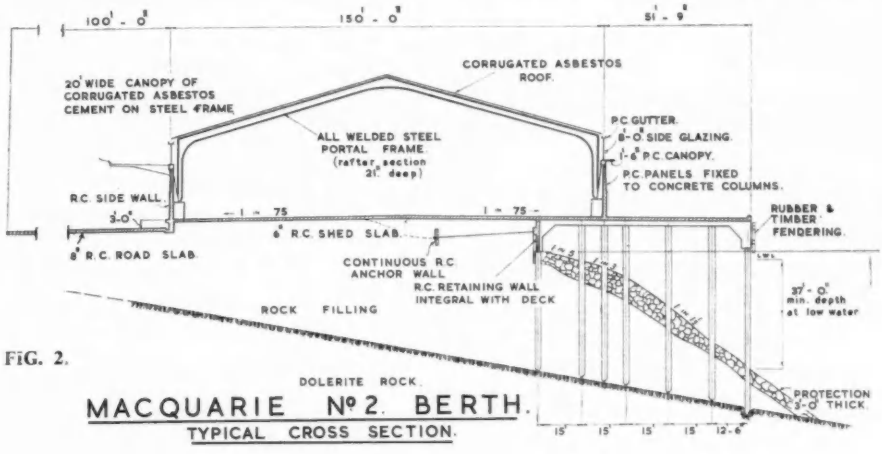

100' - 0"
150' - 0"
51' - 9"
20' WIDE CANOPY OF CORRUGATED ASBESTOS CEMENT ON STEEL FRAME
CORRUGATED ASBESTOS ROOF.
ALL WELDED STEEL PORTAL FRAME. (rafter section 21" deep)
P.C. GUTTER.
8'-0" SIDE GLAZING.
1'-6" P.C. CANOPY.
P.C. PANELS FIXED TO CONCRETE COLUMNS.
R.C. SIDE WALL 3'-0"
1 - 75
1 - 75
6" R.C. SHED SLAB.
RUBBER & TIMBER FENDERING.
8" R.C. ROAD SLAB.
CONTINUOUS R.C. ANCHOR WALL
R.C. RETAINING WALL INTEGRAL WITH DECK
ROCK FILLING
37' - 0" min. depth at low water
DOLERITE ROCK.
PROTECTION 5'-0" THICK
15' 15' 15' 15' 12'-6"

FIG. 2.

MACQUARIE Nº 2. BERTH.
TYPICAL CROSS SECTION.

It was proposed to continue with No. 3 Berth and piles for the first 125-ft. had been cast with this in view; however, the poor condition of the piles under the old Ocean Pier was rendering this berth unserviceable and it was decided, in view of the heavy cost of repairs, to rebuild this pier, as Macquarie No. 1 Berth, before continuing with No. 3 Berth. In order to clear the stock of piles, however, the 125-ft. of No. 3 Berth was first constructed.

Concurrently work is proceeding on the extension of the harbour southwards around Battery Point by the construction of Princes No. 4 Berth. It is necessary to reclaim a considerable area of land for this wharf as the ground rises steeply to the park at the rear. The berth with an ultimate length of 900-ft. and a minimum depth of 46-ft. at L.W.O.S.T. will become the main passenger berth and have facilities for the reception of passengers and a promenade deck in addition to a general cargo transit shed.

Shipping experiences difficulty in berthing at the south side of Elizabeth Street Pier because of the necessity of swinging within the harbour. In order to facilitate the approach to the berth the pier will be widened by a triangular area so as to bring the southern side parallel to Princes Wharf.

The increasing use of containers for general cargo and the success of roll-on roll-off ferries in other parts of the world has raised the possibility of a future service of this type between Hobart and the mainland ports, and for this area of sheltered water upstream of the Hobart Bridge has been selected as a suitable site.

**Macquarie No. 2 Berth**

Macquarie No. 2 Berth consists of a filled bank of broken rock (up to 9-in.) faced in the tidal range with 24-in. ballast. The reinforced concrete deck is 75-ft. wide and 600-ft long. The shed is 475-ft. long and 150-ft. wide, partly constructed on the fiilling and partly on the concrete deck, leaving a 50-ft. apron. (See Fig. 2.)

Underside of a precast prestressed deck slab showing haunching at the ends and recesses into which in-situ concrete will flow to give uniform end support.

The roadway at the rear of the shed is 3-ft. lower than the floor of the shed to form a rear-loading platform which is protected by a 20-ft. wide canopy running the full length of the shed. The roadway, which is surfaced in concrete, is 90-ft. wide, divided by concrete traffic separators into a main wharf access roadway and a loading area adjacent to the shed, each 45-ft. wide. Services are carried under the roadway in a shallow concrete duct 18-in. wide with removable slabs for easy access.

**Piles**

The reinforced concrete piles were 22-in. octagonal section 50-ft. to 85-ft. in length, having eight bars 1¼-in. or 1⅛-in. diameter, depending upon their length, and ⅜-in. diameter spirals spaced at 3-in. centres, closed up at the head and toe; the main bars projected from the head, fitting into

a special dolly during driving, and the toe was protected by a heavy cast-iron shoe of circular section cast into the pile. They were cast on the far side of the harbour and transported to the site on a specially designed pile-transporter. A 20-ton sheer legs was used to lift the piles from the transporter and hold the toe of the pile while the head was being lifted by the pile frame. The piles were then transported over the falsework in a vertical position by the 91-ft. steel pile driving frame running on rails to the position for driving.

The rock-fill bank was brought to grade before driving piles and both timber falsework piles and R.C. piles were driven through the bank. An 8-ton pile hammer was used with 6-ft. maximum drop, to drive the concrete piles to point resistance on the dolerite bottom. Piles were driven up to 50-ft. through the rock fill without any apparent damage. The piles are spaced on a 15-ft. x 12-ft. 6-in. grid.

**Deck**

The deck is of the shallow beam and slab type with beams at 12-ft. 6-in. centres running at right angles to the wharf face only. Many piles had been driven before Contract Drawings for the deck were prepared and it was noted that piles drove to within 4-in. of the designed line; beams were consequently made 36-in. wide to accommodate this range and allow a minimum of 3-in. cover over piles. The beams are continuous with a uniform depth of 30-in. except at the front and rear where there are deep haunches to accommodate the fendering and the rear wall.

The slab is 10-in. thick spanning one

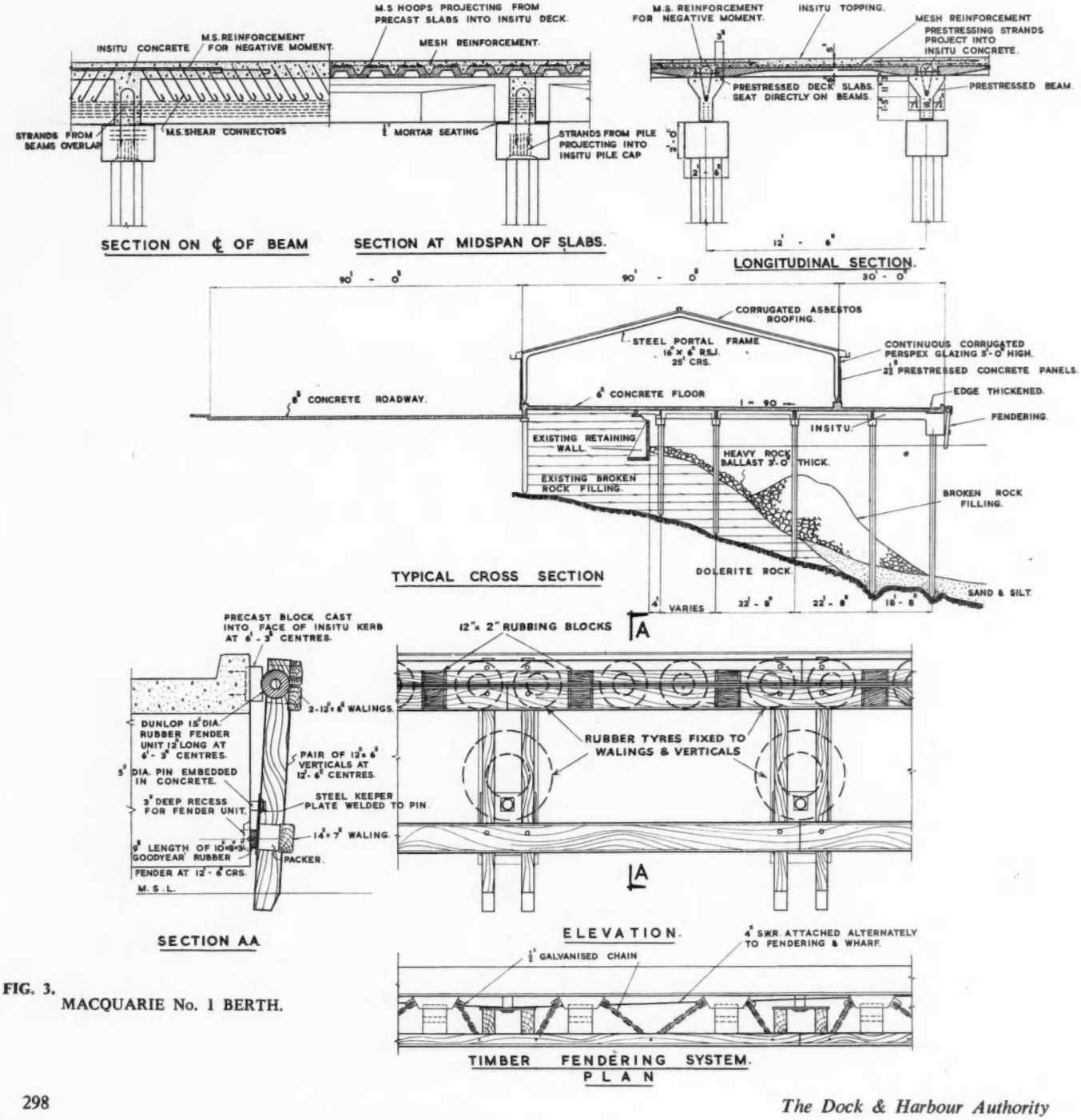

M.S HOOPS PROJECTING FROM PRECAST SLABS INTO INSITU DECK.
INSITU CONCRETE
M.S. REINFORCEMENT FOR NEGATIVE MOMENT.
MESH REINFORCEMENT.
STRANDS FROM BEAMS OVERLAP
M.S. SHEAR CONNECTORS
MORTAR SEATING
STRANDS FROM PILE PROJECTING INTO INSITU PILE CAP
SECTION ON ℄ OF BEAM
SECTION AT MIDSPAN OF SLABS.
M.S. REINFORCEMENT FOR NEGATIVE MOMENT.
INSITU TOPPING.
MESH REINFORCEMENT
PRESTRESSING STRANDS PROJECT INTO INSITU CONCRETE.
PRESTRESSED DECK SLABS. SEAT DIRECTLY ON BEAMS.
PRESTRESSED BEAM.
LONGITUDINAL SECTION.
CORRUGATED ASBESTOS ROOFING.
STEEL PORTAL FRAME 16" x 6" R.S.J. 25' CRS.
CONTINUOUS CORRUGATED PERSPEX GLAZING 5'-0" HIGH.
2½" PRESTRESSED CONCRETE PANELS.
6" CONCRETE ROADWAY.
6" CONCRETE FLOOR
EDGE THICKENED.
FENDERING.
INSITU
EXISTING RETAINING WALL.
HEAVY ROCK BALLAST 3'-0" THICK.
EXISTING BROKEN ROCK FILLING.
BROKEN ROCK FILLING.
DOLERITE ROCK.
SAND & SILT.
TYPICAL CROSS SECTION
PRECAST BLOCK CAST INTO FACE OF INSITU KERB AT 6'-3" CENTRES.
12"x 2" RUBBING BLOCKS
2-12"x 6" WALINGS.
DUNLOP 15" DIA. RUBBER FENDER UNIT 12' LONG AT 6'-3" CENTRES.
PAIR OF 12"x 6" VERTICALS AT 12'-6" CENTRES.
5" DIA. PIN EMBEDDED IN CONCRETE.
3" DEEP RECESS FOR FENDER UNIT.
STEEL KEEPER PLATE WELDED TO PIN.
RUBBER TYRES FIXED TO WALINGS & VERTICALS
14"x 7" WALING.
9" LENGTH OF 10"x 9" GOODYEAR RUBBER FENDER AT 12'-6" CRS.
PACKER.
M.S.L.
SECTION AA
ELEVATION.
4" SWR. ATTACHED ALTERNATELY TO FENDERING & WHARF.
½" GALVANISED CHAIN
TIMBER FENDERING SYSTEM.
PLAN

**FIG. 3.** MACQUARIE No. 1 BERTH.

(Above) The temporary end to Macquarie Wharf No. 3 Berth showing haunched rectangular prestressed beams with in-situ concrete over pile caps. The outer span is in-situ.

(Right) Macquarie Wharf No. 1 Berth under construction. Piles were pitched by the shear legs in the background. 6-in. thick pretensioned deck slabs span between prestressed beams and support 5-in. in-situ concrete deck.

way between the beams. Construction joints were located at midspan of the slab so that a section of deck 12-ft. 6-in. x 75-ft. inclusive of a beam was cast in each pour, and an expansion joint was provided at each end of the berth where construction was to be continued for No. 1 and No. 3 Berths. The expansion joints were of the sliding plate type and were located over beams. The 12-in. high kerb is designed to resist ultimate bollard pulls of 100 tons at normal working stresses.

**Rear Wall and Anchor Wall**

An R.C. wall 14-ft. high runs along the rear of the concrete section. This wall retains the earth filling behind the deck and is supported by the wharf structure. In order to sustain the load on the wharf due to the pressure of this filling, shed thrusts, and bollard pulls, the wharf is tied back to a continuous buried anchor wall 6-ft. in depth by 1½-in. diameter tie bolts at 2-ft. 6-in. centres, which are protected by two layers of "Denso" tape over "Denso Paste".

The Contract allowed for construction of the retaining wall in precast sections with reinforcement projecting for bonding into in-situ work. However, great difficulty was experienced in placing the first of these units due to meshing of the projecting reinforcement and a decision was then made to cast the upper section of the wall in-situ, using precast elements only for the portion within the tidal zone. The toe of the wall was protected by placing heavy ballast on the seaward side of the wall before completion of the deck in that area.

**Fendering**

A 12-in. x 12-in. vertical timber at each headstock (i.e. at 12-ft. 6-in. centres) is supported by a 4-in. diameter steel bar set into the concrete. This is free to rotate in a vertical plane and is cushioned by a 9-in. length of 8-in. x 3-in. rectangular "Goodyear" fendering at about H.W.L. This timber carries a pair of 12-in. x 6-in. walings at deck level and a 14-in. x 7-in. waling at about 2-ft. above H.W.L. The 12-in. x 6-in. walings are cushioned against 12-in. lengths of 15-in. diameter "Dunlop" rubber fenders placed at 6-ft. 3-in. centres. (See Fig. 3.)

The fendering is inclined outwards about 6-in. so that normally only the rubbers at deck level compress. When these have contracted 6-in. out of their maximum of 10-in. the lower fender rubbers also come into play, against a vertical-sided ship. Where the flair of the bow or stern contacts first only the fenders at deck level are active.

The face of the timber is protected by used motor tyres. These serve a threefold purpose:—

(1) They prevent scrubbing of the ship's paintwork against the timber fendering as they have sufficient resilience to allow the ship to move while deforming.
(2) They minimise creaking of the fendering.
(3) Because they require only a small load to deform them considerably (a load of the order of 3 tons will close them completely) they tend to distribute the fender-loading along the length of the ship and thus minimise possible damage due to high load-concentration on the ship's hull.

The energy-absorption capacity of these tyres is negligible compared with that of the rubber buffers.

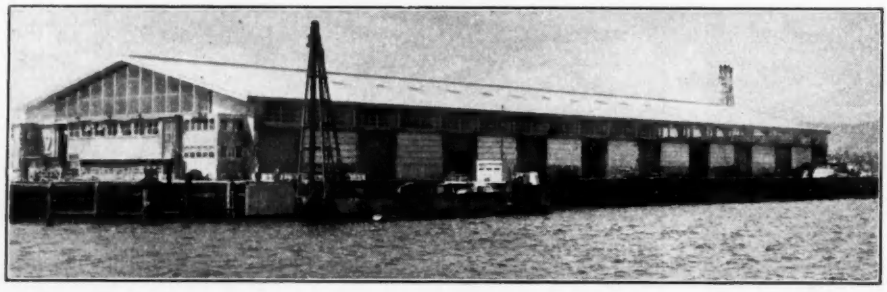
The fendering has proved entirely satisfactory and has successfully withstood a point impact from the bow of a 3,000 ton vessel which, caught by the wind, approached the wharf at an angle of about 45 degrees. Only one bay of timbering was damaged and no harm was done to the vessel or to to the concrete of the Wharf.

Macquarie Wharf No. 1 Berth face showing recesses for rubber fender units and steel pins to support suspended timber fendering.

**Shed**

The shed structure consists of a corrugated asbestos cement roof carried on a steel two pinned portal frame which is independent of the shed walls. The steel frame is thus free to expand and contract without imposing any additional load on the walls, and consequently no expansion joints are necessary.

The main frames, which are spaced at 25-ft. centres are of 144-ft. span and have a rafter depth of only 21-in. They are of all-welded plate-girder construction and are designed by "plastic theory" with a load factor of 2 for 90 m.p.h. wind loading. They are believed to be the largest span two-pin portals designed by this theory at the time of construction. An economy of approximately 16% was obtained using plastic theory design compared with the requirements of elastic theory. The frames were fabricated in five sections, levelled up on the shed floor and site welded, then erected as complete units. Owing to their weak-



Macquarie Wharf No. 2 Berth. The shed is 475-ft. long and 150-ft. wide and the side walls consist of precast concrete beams, slabs and gutter beams. The end wall glazing is in aluminium glazing bars.

ness in the lateral plane extreme care was necessary during erection, a stiffening truss being bolted to the frame which was then lifted at three points simultaneously.

The frames are connected by a light angle truss at the haunches and by 8-in. x 4-in. steel joists at 20-ft. centres on the rafter section. These beams and trusses are connected to the frames through channel stiffeners welded toes down, and thereby give lateral support to the compression flange. The 8-in. x 4-in. beams carry an intermediate 4-in. x 3-in. steel rafter at midspan which allows the use of exceptionally light purlins—2½-in. x 2-in. x ¼-in. angles spanning 12-ft. 6-in. at 4-ft. centres.

The side-walls consist of 6-ft. high R.C. Walls surmounted by precast concrete panels spanning 25-ft. between columns. The panels, which are 4-in. thick and 2-ft. 4-in. wide, were supported temporarily by steelwork cantilevering from the lower wall section while the door columns were being cast. Steel reinforcement projecting from the ends of the wall panels was enveloped in the in-situ concrete of the door columns so forming partially fixed-ended slabs. The beams at door heads and the concrete gutters were also precast with steel welding pads embedded in the upper and lower faces respectively for the fixing of the continuous 8-ft. high steel framed side-glazing.

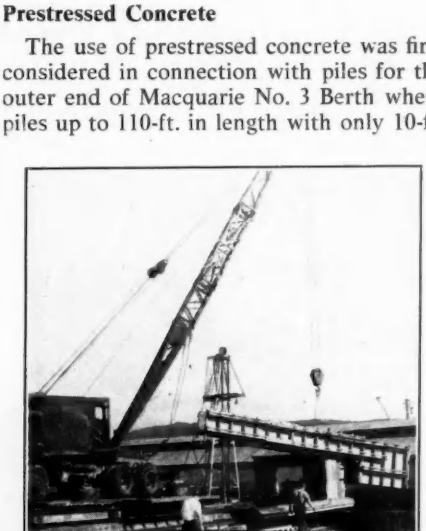
Offices, toilet facilities, broken cargo and bond stores are provided at the ends of the shed together with dining rooms and boiling water points for the waterside workers and an effort was made to produce an attractive elevation at the ends of the shed by use of large glazed areas in aluminium glazing bars. Roof lighting of perspex sheets together with the side glazing gives a minimum lighting intensity of 15-ft candles during daytime and the shed is brilliantly lit at night by cold cathode fluorescent lights fixed to the underside of the main frames consuming 32 watts per 100 square feet.

All doors are fitted with electrically operated roller shutters, the side-doors being 20-ft. in width and 18-ft. high and the end doors are 26-ft. high, of 20-ft width at the east end, and 30-ft. width at the west end. The side-doors are spaced at 50-ft. centres, i.e. in alternate bays, at the seaward side of the shed and at 75-ft. centres on the landward side. The section of the shed over the filling was constructed on spread footings to limit the maximum loading to ¾ ton per square foot but it was anticipated that some subsidence would occur and a slip-joint was provided in each end-wall of the shed on the line of the rear of the wharf. A total subsidence of approximately 2-in. has been observed.

The main contractors for the wharf were E. S. Clementson Pty. Ltd. of Sydney and the steel fabrication and erection were carried out by Johns and Waygood Pty. Ltd. of Hobart. The design was prepared and the work supervised by the staff of the Marine Board.

**Prestressed Concrete**

The use of prestressed concrete was first considered in connection with piles for the outer end of Macquarie No. 3 Berth where piles up to 110-ft. in length with only 10-ft.



T section precast prestressed beams of 22-ft. span on concrete pile caps support sheet pile bridge carrying mobile crane which is placing formwork for in-situ outer span.

of embedment will be required. In order that the equipment available, such as pile forms, pile transporter etc. might still be used, and that weights should not be excessive for handling, it was considered desirable that the size of 22-in. octagonal should be retained; columns of these dimensions lie within the "Euler" range and prestressed concrete, which could be designed so as not to crack during handling, gave a column strength at least 2.5 times that of a reinforced concrete pile of the same dimensions, as the latter would certainly crack during handling and design could be based on the "transformed section" only. The ratio of costs of labour to material cost is considerably greater in Australia than in Europe and it was anticipated that the saving in labour in the making and handling of steel "grids" for R.C. piles would offset the capital costs of converting and extending the existing pile beds to form prestressing beds. The saving was offset somewhat by the necessity to purchase prestressing steel from the U.K. instead of using relatively cheap mild steel of Australian origin but production has shown that prestressed piles cost no more foot for foot than the same section of R.C. pile, can be produced at a quicker rate, handled at three days instead of two weeks, have a smaller steel area, which facilitates the handling and placing of high strength concrete, and stand driving forces as well as, if not better than, R.C. piles. The Board has adopted as a standard the 22-in. octagonal pile and this is stressed by twenty 7/16-in. diameter high-tensile strands each tensioned to 20,000 lbs. so as to give an effective prestress after losses of at least 800 p.s.i. A ¼-in. diameter hard-drawn wire spiral is used with a pitch of 4-in. in the body of the pile and 2-in. at the head and toe.

Reinforced concrete cracks when under load whereas prestressed concrete may be designed so that no cracking will occur. This is an obvious advantage in wharf structures where cracks allow the entry of moist salt air to the steel. With this in mind the Board now uses prestressed concrete in preference to reinforced concrete where possible and has set up its own casting yard with six beds each 240-ft. in length, three designed for 50 tons pull and three for 200 tons pull. The 200 ton beds are used for pile and beam manufacture and the 50 ton beds for deck slabs, shed wall panels, floor soffits and the like. The layout of the beds was based upon the necessity to produce about 20-ft. of wharf deck 80-ft. wide per working week, without any special curing, for the current works programme.

**Macquarie Nos. 1 and 3 Berths**

Prestressed concrete has been used for the deck of both these new berths and pre-

stressed piles also were used in No. 1 berth. As there was less than 5-ft. of silt and sand overlying the rock at the face of the wharf it was necessary to form a toe-hole for the two outer rows of piles and this was accomplished by jetting a 5-in. diameter steel pipe through the overburden, placing a 5 lb. charge of "Hydrogel" through the pipe, withdrawing the pipe and firing the charge.

The piles are capped by a block 2-ft. 6-in. by 3-ft. by 2-ft. deep and the precast beams are seated on a mortar bed placed on this cap, leaving a gap of 18-in. between the ends of the beams, over the cap, which is filled with in-situ concrete when the deck is cast. Mild steel reinforcement is added in the deck over the piles so that for live load the beam is continuous, normally reinforced for negative moment and a prestressed T-beam for positive moment. Steel shear connectors tie together the beam and topping slab to ensure composite action.

As it was realised that the piles could not be driven to an accuracy of less than about 2-ft., beams are not cast until all the piles for that headstock have been driven. The beams are then "tailor made" to suit the pile spacing. This does not cause any delay as the pile driving is always kept well ahead of beam placing. (Beams are placed immediately after the release of prestress and a 20-ton crane has travelled over the beams only two weeks after casting.)

For No. 3 Berth the spans of headstocks were 15-ft. and the beams were of section 24-in. wide by 13-in. deep, having fourteen 7/16-in. strands. The beams were deepened to 19-in. at the ends to reduce the eccentricity of the prestress and provide sufficient depth for negative moment.

For No. 1 Berth the spans were increased to 22-ft. (This is the limit imposed by an arbitrary maximum load of 100-tons per pile). The beams were of T section 31-in. deep, widening to rectangular section at the ends. The flange of the T acts as a seating for the deck slabs. (See Fig. 3.)

The prestressed deck slabs, which are of single inverted U section 6-in. deep and 2-ft. wide, span 10-ft. 6-in. between beams and are stressed by four $\frac{3}{8}$-in. strands. The ends of the slabs are recessed so that initially only the corners seat upon the beams and the slab is free to rock if there should be any warping of the slab or if the beams are not of the same slope. A 5-in. thick in-situ concrete deck was cast over the slabs and the concrete filled the recesses in the ends of the precast units so providing an almost continuous seating. This in-situ slab distributes heavy wheel loads laterally over the deck slabs, provides a smooth running surface for forklift trucks and trolleys and acts compositely with the deck-slabs to form a slab with an effective overall depth of 11-in. The first slabs produced were castellated and had steel ties to develop composite action but tests indicated that even with a smooth trowelled surface and only lifting hooks at each end the bond between in-situ and precast concrete was sufficient to cause the slab to fail in bending before any slip occurred at the interface even under the most severe shear conditions. Only nominal steel ties are now used but the surfaces of the slabs are wet sand-blasted immediately after stripping from the beds to remove laitance.

Retaining wall consisting of slotted precast counterfort units placed on a prepared bed with precast prestressed panels spanning between units.

The mesh reinforcement for transverse moment is laid directly on top of the deck slabs and the longitudinal joint between slabs is shaped so that a 4-in. deep V is formed which fills with in-situ concrete to give cover to the reinforcement over the joint. The slab carries the dead-load of in-situ concrete as a simply supported slab but mild steel reinforcement is added in the top of the in-situ slab over the beams so that the slab is continuous for live loads acting as an R.C. slab for negative moment and a prestressed slab for positive moment.

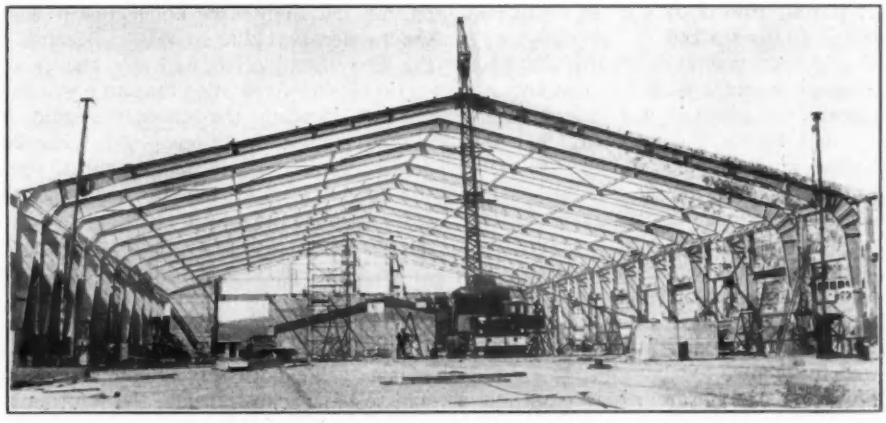
In order to allow fendering to be suspended from the wharf face and to facilitate alignment of the face of the wharf with varying pile positions the outer span of each beam and the kerb-beam carrying precast units for the positioning of rubber fenders are of normal reinforced concrete construction.

**Rear Wall**

At the rear of the concrete structure the rock-fill is retained by a wall made up of precast units. The principal units consist of a base 11-ft. by 7-ft. and a column 2-ft. 8-in. by 2-ft, attached to the base through a concrete stiffening rib with a slot each side into which precast prestressed panels $7\frac{1}{2}$-in. thick and 12-in. wide are placed The units at 12-ft. 6-in. centres, are placed on the rock fill after first levelling the surface with $1\frac{1}{2}$-in. crushed metal. The wall is stable up to a height of 12-ft. and is speedy and easy to erect. In order to allow for any subsidence that may occur at the rear of the wall a continuous strip footing was cast about 8-ft. back from the top of the wall and a simply supported approach bay, of beam and slab type similar to the deck, spans between this footing and the innermost pile.

**Shed**

At the time of writing, construction of the shed on No. 1 Berth is about to commence. The design will be similar to that for No. 2 Berth, but the span will be reduced to 90-ft. due to the limitation of space at the rear and 16-ft. by 6-in. joist section will be used in lieu of a built-up plate girder section. The side-glazing will be continuous "Perspex" glazing 5-ft. high and precast prestressed panels $2\frac{1}{2}$-in.



Macquarie Wharf No. 2 Berth shed during erection of the 144-ft. span steel frames. Note the single braced bay and light angle purlins. The rafter section is 21-in. deep and 10-in. wide.

thick will be used for the lower section of the wall spanning vertically between steel girts fixed to the main frames. The panels will be removable for replacement in case of damage.

It is anticipated that the berth, which was started in March 1959 will be ready to receive shipping in the 1960 fruit season. The Civil Engineering work is being carried out by day labour except for the fabrication and erection of the shed steelwork, which is being undertaken by N. G. Sherrin Pty. Ltd. of Hobart. The design for the berth and of the prestressing installation was prepared by the Board's engineering staff.

**Wharf Loadings**

For some years an arbitrary loading was used for Wharf deck design, namely:—

8 cwts/sq. ft. for slabs
7 cwts/sq. ft. for beams
6 cwts/sq. ft. for piles

While this was readily applicable to small areas and close pile spacings an investigation into the possibility of opening up pile spacings by the use of prestressed concrete construction showed the loading to be excessive over large areas; for instance a beam supporting an area 30-ft. by 12-ft. 6-in. would be designed for a load of 130 tons. The worst uniformly distributed load encountered over large areas was that due to a loading of 5-cwt. per square foot. This newsprint in rolls stacked five high giving loading was exceeded over small areas by tinplate, steelplate and similar materials in stacks 2-ft. 6-in. to 3-ft. high, giving loads up to 12-cwt. per square foot, but generally limited in size of shipments to 100 tons. Steps have been taken to regulate the loading more severely by limiting it to a maximum of 8 cwts per square foot with the provision that in any 100 square feet of deck the load should not exceed 25-tons.

As an alternative loading, to allow for the importation of transformers and similar heavy loads on wheeled vehicles, the designs are checked for a 20-ton transporter with eight dual wheels carrying a 60 ton payload, giving eight 10 ton wheel loads at a standard spacing.

**Conclusion**

The use of precasting has permitted the rapid construction of permanent wharf facilities with the minimum of site labour and the advantages of factory-like control of concrete and steelwork in the casting yard.

The trade of the port has doubled in the past 25 years and should continue to increase, requiring better handling facilities, more berths and bigger sheds. The requirements for the future are well catered for in the proposed development plan for the port.

# A Movement Predictor for Floating Bodies for use with a Sea-Wave Recorder

by L. Draper, M.Sc., A.Inst.P., National Institute of Oceanography
and F. A. Roberts, A.M.I.C.E., C. S. Allott & Son

One of the operations in the building of the nuclear power station at Hinkley Point, Somerset, was the construction of the cooling water inlet in tidal waters 2,000-ft. offshore.

The water inlet could have been constructed in a cofferdam, but it would have been difficult to build such a structure in the sea because of the tidal range of 40-ft. and currents of up to 3 knots. Atlantic swell could be expected to make the task even more difficult. For these reasons, it was decided to build a caisson in a dry dock excavated onshore, and when completed to float it out, tow it to the inlet site, and locate it on the sea bed.

The caisson was cylindrically shaped in reinforced concrete with its sides enclosed by steel sheet piles; it was 60-ft. high and 90-ft. in diameter and weighed 3,900 tons. It had eight adjustable "spud legs" to enable it to be levelled on the sea bed.

The towing operation could only take place at high spring tides because only then was there enough depth of water to float the caisson over an offshore rock bar. This meant that there was an average of only five tides in each month when it could be towed to its site.

Ship-tank tests were carried out on a scale model to determine the effect on the caisson of those waves liable to be encountered during the towing and sinking operation. These tests showed that the caisson had natural periods of oscillation of between 10 and 14 seconds. Waves 1 foot high with a period within the critical range could cause the caisson to move up and down as much as 4.8-ft., whilst waves with periods of less than 9 seconds would have almost no effect. For wave periods greater than 14 seconds, the caisson movement would be nearly the same as the wave heights. As waves in the critical period range are commonly present in the Atlantic and can easily penetrate up the Bristol Channel, precautions had to be taken to ensure that there were none present when the caisson was due to sail. Because of the early completion date for the power station it was imperative that no opportunities of locating the caisson should be missed; to wait for a completely calm day could mean a delay of many months. From the model tests it was obvious that the caisson could be towed and located in a choppy sea provided that there was no swell liable to produce synchronous movement. Unfortunately, the human eye is unable to detect a swell under-running choppy waves. It was therefore necessary to have a means of measuring both wave hight and period and to be able to translate the information directly into a description of the behaviour of the caisson. The measurement of wave height and period is a standard technique, but a conventional analysis to discover whether unwanted periods exist is a long process; for this problem an automatic and immediate method of analysis was needed.

Consequently, an instrument which would produce this analysis was devised. It consisted of an electronic filter and amplifier which responded to the output of the wave recorder in the same way as the caisson would respond to the actual sea waves: in other words, the response curves of the filter and of the caisson were the same (see Fig. 1).

The filter was a modification of a high-Q twin-T filter (Tucker and Draper, Electron. Engng., Vol. 27, 451-453, October 1955); a twin-T rejector filter was incorporated in the negative feedback path of an amplifier, thereby forming an acceptor or band-pass amplifier. The caisson resonance was the combined effect of heave and roll resonances; these were close to each other in period (see Fig. 1) and so two such filter units were placed in series, one having a pass-band around the heave period and the other around the roll period. The relative response of the two units was adjusted until the overall response of the filter agreed closely with that of the caisson.

The outputs of the wave recorder and of the filter (or caisson-movement predictor) were displayed on a twin-channel chart-roll recorder. The sensitivity of the wave recorder was $\pm$5-ft. and that of the filter $\pm$2.5-ft. These charts were direct reading, with the exception that because the wave recorder was of a type which measured pressure changes on the sea bed the attenuation of sea-waves with depth had to be allowed for in the usual way; because of the narrow period range of the filter it was necessary only to multiply the indicated

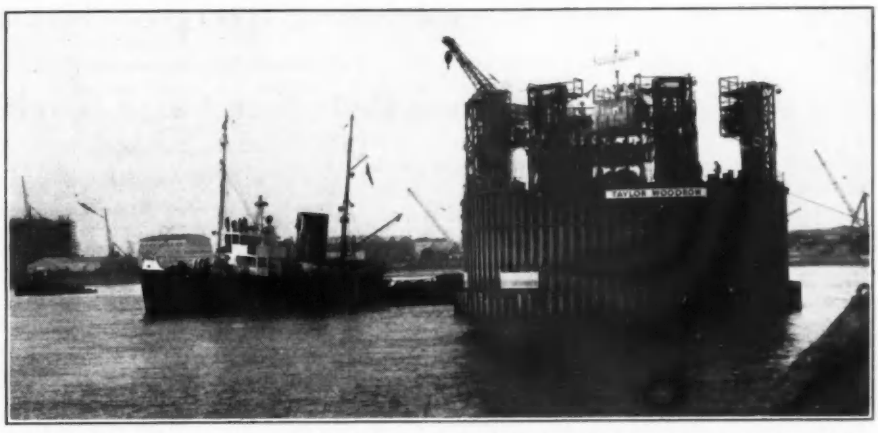
caisson movement by a fixed factor to obtain the true predicted movement. As a check on the performance of the apparatus, records of waves recorded during a storm were analysed by the longer conventional methods. The caisson movements deduced from these analyses were in close agreement with the movements predicted by the filter at the time of the storm.

In addition to a direct measurement of actual sea conditions, it was essential to have a good sea-state forecast for the four hours immediately following the launching of the caisson, as the whole operation was liable to last this length of time. As waves arriving in the Bristol Channel may have been generated ten days earlier in distant parts of the Atlantic Ocean, it was necessary to study the meteorological conditions over the whole North Atlantic Ocean for the ten days immediately before the sailing date. This was done using weather reports specially prepared by the Meteorological Office, and forecasts were issued by Dr. J. Darbyshire of the National Institute of Oceanography.

The caisson was eventually moved from its dock on the morning of June 20th 1959. The wave recording equipment showed that the prevailing sea conditions should induce only a negligible amount of caisson movement and the forecast indicated that those conditions should continue.

The towing and lowering operations went according to plan. The fact that the whole operation was safely and satisfactorily carried out at the first attempt illustrates the value of a detailed knowledge of sea conditions, forecasting methods, and techniques of wave measurement and analysis.

The power station has been designed and built by the English Electric, Babcock and Wilcox and Taylor Woodrow Atomic Power Construction Company Limited for the Central Electricity Generating Board. The design of the Intake has been developed by Messrs. C. S. Allott and Son, Consulting Engineers, who are associated with Taylor Woodrow Construction Limited. The authors are indebted to their colleagues for their assistance, and to the National Institute of Oceanography and Taylor Woodrow Construction Limited for permission to publish this article.



The caisson under tow by the tug "Metinda III" during the successful launching on June 20th, 1959.

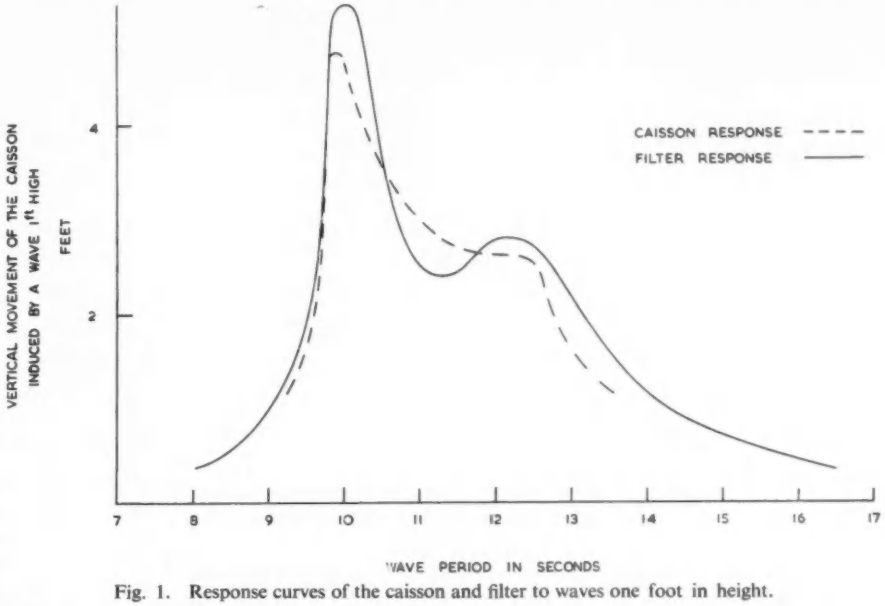



Fig. 1. Response curves of the caisson and filter to waves one foot in height.

## Tankers as Grain Carriers

An important factor at present affecting tramp owners is the abundant supply of oil tankers which are entering the grain trade. It was only about three years ago that tankers obtained a foothold in this trade in the United States and the practice has spread to the extent that a substantial portion of U.S. grain exports are now being carried in tankers. Initially there were unfortunate experiences arising from contamination of grain in ships which had not been properly cleaned, but suitable techniques have since been developed for cleaning dirty tankers, and the high requirements of cleanliness required for the trade are now being met.

The tanker is reasonably well suited for grain cargoes. Because of the high degree of sub-division, the danger of cargo shifting does not arise and, provided the strums boxes of the stripping lines are protected by wooden boxes so that they cannot be choked with grain, drainage presents no difficulties.

It is necessary to arrange for ventilation, and this can be done readily; Lloyd's Register allow a ship thus equipped to sail at the deeper draft appropriate to tankers. Loading is done in the orthodox manner, under the elevators, and normally discharging is done by suction in the ports equipped for the trade. In undeveloped ports, discharging is slow but a new portable equipment has been developed which should overcome this disadvantage. This equipment, described in a recent issue of " Marine News " (New York), is used without modification to the structure. For a T-2 tanker, ten units are normally used, each serving five tanks. The suction pipe is led to the tank and the grain is drawn up and passed through a cyclone to separate grain and air; the grain is then blown ashore through a discharge pipe. These machines can each discharge grain at the rate of 50 tons per hour, over a distance of at least 250-ft. Despite its high efficiency and power, the equipment is simple and not difficult to operate; it can be carried in the tanker's cargo hold forward. This development is likely to increase the competitive power of the tanker in the grain trade by extending its range to ports which are without grain-discharging equipment.

# Mechanical Equipment in Ports

## New Methods in Cargo Handling*

By Col. R. B. ORAM, O.B.E.

### 1. Introduction

Before 1939 the work of handling cargo, to and from ships, was done almost entirely by manual means. There were, of course, quay cranes, many of which were still hydraulically operated; ships were equipped with winches, a few of the more modern having the electric type. Electric trucks for transporting sets of cargo from and to the ship's side were to be found where port conditions permitted their use and port authorities sanctioned the heavy expense of buying and maintaining equipment, some of which had still to prove its worth. The bulk of the cargo that passed through the ports of the world was still transported in small units by men pushing hand trucks.

Under the stimulus of war conditions, with the urgent need to move cargo through damaged ports and over the beaches and without the restrictions imposed by commercial economics, the invention of handling machinery suitable for cargo leapt ahead. The hand truck can operate only over flat or prepared surfaces, which are unlikely to be found under active service conditions. To cope with these, and the absence of such long accepted amenities as crane tracks and rail lines, the mobile crane was developed. The forklift truck (invented many years earlier but allowed to lie dormant) was made more robust, and tractors and trailers were called upon to face cruelly hard conditions. Generally, a new comprehension of dock operations which broke away from the conventional came to be accepted.

### 2. Functional

To understand the revolution that had taken place, the fruits of which were waiting to be picked by the post war operator, it is necessary to examine briefly the range of operations that form the daily work of a port. Then we shall see how they have been changed as has also the design and contruction of the premises in which cargo operations are carried out.

The essence of port work, save in the activities of the special commodity warehouses such as frozen meat stores, wool showrooms and timber storage plants, lies in the movement of goods. Apart from warehousing the work is one of continuous transit. As soon as the goods are out of the ship's hold they are needed by the consumer whose premises may be many miles distant from the port. To bring goods to the ship's hold a journey of many miles may be involved of which only the final stages are comprehended by the port. The function of a port authority or a dock company is to sell facilities for the transportation of goods. Making it possible for lifting, lowering, moving, piling, unpiling, transferring, and generally picking up and putting down again of the myriad forms that modern cargo takes, to be done in an efficient manner, that is the end-product of the dock owners' business. The measure of his efficiency in providing and maintaining these facilities is guaged by the speed at which ships can be turned round in his port.

It follows, therefore, that no dock owner—and this term can conveniently be made to include shipping companies, master stevedores and other employers—responsible for port operations, can afford to have his dock equipped with less than the most modern and up-to-date mechanical equipment. The variety is today both extensive and confusing. Extensive because nearly every implement or machine developed for materials handling is held by its maker to be potentially valuable if it is given its chance in the docks. Confusing because the first cost is high, maintenance is a continuous overhead, labour's reaction may be less than enthusiastic and there is no guarantee that the equipment is going to prove functionally suitable for the dock operation contemplated; in spite of the maker's optimism.

Still on the question of functional machines the author of this paper has had a continuous experience of rejecting equipment because he was not satisfied that the maker understood the dock operation for which the machine was recommended. To give an instance, there are two main methods of handling softwood timber once it has been landed from a ship. The first method is to receive the sets shore, truck them to a piling area some distance from the discharging berth, where they are left until suitably skilled labour can tackle the job of sorting and piling to sizes. What is functionally necessary is a means of moving the timber economically from the ship's side to the piling ground, thereby keeping the berth clear for the following ship.

The second method, used where there is a large number of berths, and also a high proportion of overside deliveries, is for the stevedores to make a bulk of timber on the quay. By the time discharge is completed the quay alongside is completely blocked in with timber waiting to be sorted and piled to size on ground which is within carrying distance. This method is practical because the dock company receive the cargo on the quay free of expense, there are ample berths for incoming ships and sufficient piling ground behind the berths.

With the first method a machine of the straddle carrier type, or even a tractor and trailer, is essential. With the second method no machine is required. The mobile crane used for piling the sorted timber is, of course, common to both methods.

The author, who for some years was responsible for operating the second method, was persistently importuned to purchase straddle carriers on the grounds that they would each transport a standard of timber at 30 miles per hour. The fact that the timber remained in the neighbourhood of the berth was ignored. The instance is mentioned to show how easily the functions of the different types of equipment for cargo handling can be confused.

This confusion is most easily come by because there is no hard and fast line between the work that each type will do, or can be made to do, by an ingenious operator. Beginning with the primitive mechanical equipment, the electric truck, its job is to transport more cargo in one journey than its driver could do on his own. Before long a small type crane came to be fitted because it was considered an advantage for the driver to be able to pick up a load. The mobile crane is mobile but its mobility should be kept within limits. Its early career was marred by drivers who travelled over long distances and over uneven ground with a load suspended from the jib. The tractor is intended to haul trailers or even to shunt wagons. It is not meant to persuade heavy and recalcitrant quay cranes to move along an uneven crane track. Forklift trucks lift, lower and transport goods but, again, if a set has to be taken for say, half a mile, it is abusing their function to make them do work

*Address delivered at a Seminar on Ports and Shipping Training held in Copenhagen, October 1959.

better done by a powered truck or trailer. Every port operator could quote examples where, through ignorance of the function of a type of cargo handling equipment, machinery is being wrongly used, to both its detriment and its capacity to save money.

3. **The Machines to do the Job**

Having established that dock equipment is primarily functional what are some of the machines that can properly be used to help in the operations that have been listed?

(a) **Lifting and lowering cargo:**

Quay cranes
Mobile cranes
Forklift trucks
Wall and warehouse cranes.

(b) **Transporting cargo:**

Trucks, electric, diesel etc.
Trailers and tractors
Conveyors
Belts
Straddle carriers

(c) **Piling and unpiling:**

Piling machines, fixed and mobile
Forklift trucks
Mobile cranes
Overhead gantries.

There is also the specialised equipment to be found in warehouses built to handle bulk cargoes such as grain, sugar and ores; the floating suction elevator is also too specialised to be included in the general mechanical equipment, units of which, it will be observed, have often more than one use. This is in no way contradictory of their functional purpose; it simply means that the operation of lifting and lowering cargo is contained in a lesser part, in that of piling and unpiling.

What is of extreme importance is the mobility of most of the new mechanical equipment. For decades the application of machinery to port work was governed by the need to take the job to the machine. The ship must go to the berth where the quay cranes are installed, heavy logs of timber can be handled only in sheds equipped with overhead travelling cranes, bag cargo can be piled only in warehouses where there is electric power to operate the primitive types of piling machines—in sum, the port came, in time, to be divided physically into areas and installations devoted to the handling of particular commodities. This was sound when the volume of traffic was sufficient to keep fixed machinery working every day in the year. When there is no ship to be discharged cranes lie idle; they cannot easily be used for other work. When the import of timber falls off, overhead gantries still have to be maintained although no alternative cargo offers. Although the machinery has been carefully selected and is operationally adequate it represents a dead loss whilst it is not employed. On the other hand, if the same amount of thought is applied to the purchase of mobile equipment there is little difficulty in taking the machine to the job. As will be explained in the next section of this paper, it is then gainfully employed for as near to 100 per cent of its time as is possible, in the uncertain work of cargo handling.

4. **The Practical Use of Mobile Cranes etc.**

The first stage in the practical use of any piece of mechanical equipment is to buy the type that will give the user the maximum satisfaction. It is perhaps the most difficult job of all as it is one which the user will have to rely largely on his own judgement.

The machine that will give satisfaction must have the following qualities, apart from the obvious one of being able to stand up to the arduous conditions of port work, a future for which many earlier types, intended for the placid work of depots or factories, were conspicuously unsuited.

(a) It must satisfy the prospective buyer that it will do the job better than it is being done by the present means.
(b) It will make sufficient saving to pay for itself and for its maintenance.
(c) There must be a reasonable prospect of saving, in addition, sufficient for replacements. Most mechanical equipment has a comparatively short life, not often beyond 10 years, although there has not been sufficient experience since 1945 to pontificate on the useful life of a forklift truck.
(d) It can be used on other cargo when not required for the job for which it was purchased.

In regard to the first premise, it is necessary to avoid falling into the trap that stretched invitingly before he pioneers of port mechanisation for its own sake. There are still many jobs in the ports, and there will always be some, that can be done more cheaply and more effectively by hand, despite the syren songs of the would-be vendor of attractively advertised machinery. Secondly, the user must see an obvious saving per ton in the cargo handled by the new machine. This implies a reduction in the number of men employed or such an increase in output as to reduce considerably the cost per ton, or, of course, both of these. It also implies that the machine is not of a type to alienate the men who will have to use it and whose co-operation is essential. Maintenance must be simple because as soon as a prospective user decides on equipping himself with the means to work mechanically he has to face the engagement of a staff of fitters and the probable erection and equipment of an up-to-date garage. If the machine is carefully chosen then repeat orders can be placed, which means that only one range of spares has to be carried in the garage. Tailor made machines may embody improvements and may minister to the whim of the port operator but the fewer types that can be agreed upon, the cheaper will the maintenance come out. An early user of mechanical equipment, before he had learnt this lesson, remarked ruefully "What I saved at the ship's side I lost in the garage."

In regard to replacement at the end of the useful life of the machine first selected, if its performance has been carefully watched and checked, then it is not difficult to see exactly what improvements are called for. If these are simple and functional they can be embodied by the makers in the new range of machines all of similar type—Mark II, as one might describe them. Maintenance is thus simplified.

The fourth of the criteria is the point on which we touched when talking about taking the machine to the job. How often has a prospective user been assured that the seller has just the machine for piling timber, for stacking wool, for piling cases of oranges or for transporting bananas. There is little doubt that the seller is correct in saying this. He is not overmuch concerned if the timber season is a short one, if the wool trade is variable in its demands or if oranges come only at certain times of the year or if a machine for handling bananas is not likely to be of any use for landing bags of sugar. Whatever the operators satisfaction at leaving his competitors behind during the timber season this is likely to be dimmed as he watches, month after month, a moth ball fleet of specialist machines, waiting for the start of the new timber season before they can again go into action. To illustrate this principle the author would like to quote a simple case where a new type of specialist crane was produced so that it could be easily adapted for general business.

In the dock where he was in charge work on softwood timber had shown the need for a mobile crane that could pick up a load of 1 ton from the rear stowage of the storage shed spanning the obstruction of a 15-ft. pile in front. When the time came to buy new cranes, the need was explained to the manufac-

turers and a sturdy crane, high mounted, was evolved by them. Its distinguishing feature, and one that enabled it to pick up the distant set, was an angled extension to the jib. When the crane was not wanted for work of this kind the extension could be dismantled by a fitter in 20 minutes and the crane then became a general, all-purpose machine. As a result, the new type cranes gave complete satisfaction on timber piling from October to March and for the rest of the year were available for use, anywhere in the port on any type of general cargo. Thus the combination of specialised and general work has produced an ideal of continuous work throughout the year.

5. **Training the driver**

Nowadays the importance of the mobile and forklift truck driver is generally recognised. In fact some manufacturers, knowing that a contented driver is their best advertisement, go to great pains to teach prospective drivers how to operate the machines that they hope the employer is going to buy. The use of the mobile crane introduced a principle of mechanics that, familiar vaguely to the winch driver who kept one eye on the angle of the ship's derricks, had, with safety, been ignored by generations of quay crane drivers. They were secure in the knowledge that a crane scheduled to lift 3 tons would pick up and put down a load 3 tons irrespective of the angle of the jib. The manufacturers of mobile cranes were not without responsibility for a state of affairs that, through ignorance, put many of the early mobile cranes into the dock. Anxious not to understate the power of their product, a mobile crane—that would just lift 3 tons with the jib as nearly vertical as practicable, with the four wheels standing on hard and level ground and with each tyre correctively inflated—was handed to the often unsuspecting driver who found that, in practice, picking up a bulky 3 ton lift, with the jib at a practical plumbing angle, could just not be done. If he was sensible he gave up trying whilst his four wheels were still on the ground. These "vest pocket lifts", as the theoretical capacity of the crane came to be called, had to be wiped out and forgotten entirely before mobile cranes could be safely used in the conditions of normal dock work. How many different angles, for instance, has the jib of a crane to be set at in order to plumb over a barge load of cargo, or to place a set on to a lorry?

These and other problems were tackled by forward looking employers who realised that existing safety regulations were becoming obsolete and that new legislation would, for many years, lag behind experience. Several issued their own "standing orders for the guidance of mobile crane drivers". Although these did not have the force of law they were valuable aids to safe working.

The forklift truck has also introduced problems of stability, whose lessons have had to be learnt the hard way. What is to be said to the driver of a laden forklift truck who swings his machine lightheartedly round the shed, ignoring a fact with which he has always been familiar, that the shed floor has been built for drainage purposes with a slope of a few degrees? When he, his machine and his load turn over, he finds himself up against what is to him an entirely new principle of mechanics. Loads carried some way from the ground—and this may be necessary with a bulky package such as a cased car, negotiating a narrow gangway—present new problems. Tests on stability have been carried out by manufacturers and others, and again, standing orders for forklift truck drivers, are becoming available.

Many of the early drivers of the new equipment received their training under service conditions during the late war. Their skill and their co-operation, greatly simplified the job of the pioneers of mechanisation. Today most employers have their own arrangements for training potential drivers. Once the difficulties have been mastered, working conditions compare most favourably with other port workers. On the opportunities for higher earnings we shall have more to say shortly. There is also the satisfaction that comes from the possession of individual skill and the knowledge that one is playing an important part in the future pattern of dock work. Threats of redundancy mean less to the mobile crane and the forklift truck driver.

6. **Impact of Mechanisation on Working Conditions**

This silent revolution which has altered the face of many ports, has done away with the orderly confusion of ship discharge. It has replaced the scurrying crowd of hand truckmen, moving monotonously between the crane and the shed, by a few forklift trucks, each with its own driver, making in one cycle of movement the equivalent of perhaps a dozen truckmen.

This revolution is, as we have been at pains to make clear, so far only partial. Whilst a high proportion of the work in some ports has been mechanised, in others the ideas of mechanisation have not disturbed the conventional set up.

Results in the former ports can, however, already be discerned and classified. They can be set out, very briefly:—

(a) Effects on working conditions i.e. methods of paying labour for work done.
(b) Changes in the nature of the cargoes.
(c) Influence on cargo conditions.

(a) **Payment of labour.** In many of the major ports there is agreement that the benefits accruing from mechanisation shall be enjoyed equally by employer and worker. The interpretation of this agreement has not always been made in a reasonable way and sudden troubles have flared up. Where it has been interpreted in a farsighted manner the co-operation of labour has been forthcoming, for the very obvious reason that the worker can now take home a larger pay packet, with much less physical effort. Work that everyone can do is seldom well paid, neither does it give scope for exploitation by the worker. Trucking bales of wool and making bags of sugar up into sets is arduous, increased piecework earnings can be had only by the superhuman effort that, sustained over the years, inevitably shortens the working life of the docker. "Too old at 50" was, until recently, the verdict on timber porters and such like workers on heavy cargoes.

To overcome the reluctance of workers to accept smaller gangs in spite of the higher individual earnings that usually go with these, a new approach has been proved effective. To advise the workers that where 15 men have previously done the job, only 8 will now be required (and this number will include the drivers of two mobile cranes) is to invite opposition. If, however, it is explained that an entirely new approach is to be made to the job—and in many cases the damaged condition of the ports in 1945 made this approach completely sincere—then it has been found possible to build up a new piecework gang around the keymen, the mobile crane or forklift truck drivers. Under the name of "balanced gang" a completely new piecework system has, in some ports, been superimposed on the manual scale that is gradually falling into desuetude. Port employers can afford to agree generous piecework rates for mechanised operations. Although daily earnings may be on a scale that would have been incredible in pre-war days the employer stands to gain. As an example of this, exports were, at one berth in London, received and shedded by a gang of six men working with hand trucks. Taking the normal delays into account 50 tons was considered a reasonable out-turn for an eight hour's day. Overtime was normally necessary. When the job was mechanised 3 men, including the drivers of a mobile crane and forklift truck, had no difficulty in striking and shedding 300 tons in eight hours. Overtime became unnecessary. Taking into account overheads such as tallying, supervision, attendance of tackleman, use of gear etc., the cost per ton, in spite of increased personal earnings, rocketed down.

(b) **Changes in the nature of the cargo.** It is a truism that no change can be made in the accepted method of handling cargo

without its effects being felt in a widening circle, none of which may be apparent when it is decided to make the change.

The size of cargo units is governed by the known means for handling them. If you are shipping through a port where the lifting capacity is not more than 1 ton it is waste of time to tender cargo in units of 4 or 5 tons. Where hand labour is responsible for the cargo after is has left the ship's purchase or the quay crane or until such time as it reaches these, then the size of packages must be in terms of hundredweights and not tons. The smaller the package the more damage it is likely to sustain through repeated handling. Damage invites pilferage.

(c) **Influence on cargo conditions.** When it is known that a dock company or a shipping company can handle cargo by the pallet load, this is an invitation to the regular shippers of homogeneous cargo to tender cargo in unit loads. Not only can these be catered for, but the awkward and bulky package can be handled with ease by a combination of forklift trucks and mobile cranes. In this way there is a constant tendency for cargo units to become larger and heavier, and for the cost of packaging per ton to be reduced.

To take the process a stage further, mechanisation is a direct incentive to the carriage of cargo in containers. To take a single example. From time immemorial wine has been shipped in casks. Casks are a delicate and very susceptible form of packing. Skilled coopers are required to attend the casks whilst they are being shipped. Special stowage condition are called for and only a limited weight can be carried. Before discharge takes place each cask has to be sounded out by a cooper, who generally remains, watching the cargo until it is delivered. Each bottle of wine has to bear its proportion of this cost, which is additional to the freight charged. Consider the case of the ship fitted with glass-lined tanks into which the wine is pumped at shipment. At the port of discharge the vessel is berthed alongside the consignee's premises. The wine is pumped direct into vats, from whence it is bottled. On a smaller scale there is now a traffic in vermouth carried in containers which are lowered into the hold of a general cargo ship and discharged subsequently by quay crane.

Container traffic is greatly on the increase. It is taking many forms from the 35 ton giant carried by specially built American vessels to the small collapsible type that is becoming popular in the Continental trade. Without the mobile crane and the forklift truck—and it must not be overlooked that mammoth types of both are now available for port use—the container would figure only in overland traffic.

(d) **Pilferage.** "Nobody misses a slice off a cut loaf" is a French proverb that had, no doubt, a moral point. It sums up in a few words the problem of pilferage in the ports. Only the the expert thief will have the skill, and the privacy, to open a wire bound case, to steal the contents. Once that case has been dropped or crushed the chances of the contents being safely transferred to a newly made package are indeed reduced.

Poor packing provies ample opportunity to would be pilferers. The smaller the unit the more expensive it is to thwart the pilferer. 10,000 bottle of whiskey packed six at a time, in wooden cases, might reach the consignee intact. Very few experienced port operators would be prepared to guarantee their safety, particularly as the makers name is always conspicuously branded, so that "he who runs my read".

The wartime consignments of N.A.A.F.I. cargo with their parent mark of a white diamond on a black background, would have fared better had they been carried in securely locked containers. The point hardly needs labouring. It is sufficient to add that, apart from wilful pilferage, casual damage is avoided by the use of containers. Insurance premiums are also less.

**7. Effect of Mechanisation on Port Installations**

Apart from the construction of port premises for the specialised handling of meat, grain, bananas, wine etc., the type of shed and warehouse for general cargo has within living memory hardly changed until the last decade. Regard in the design of dock premises was paid more to the type of cargo and the space that could be made available. One hundred and fifty years ago five-storeyed warehouses were built, each floor to take vertically two hogsheads of sugar. This marked the latest thought of the times in warehouse construction. Some of these warehouses have survived war-time bombing; they are impossible to adapt to mechanisation. Many dock sheds were, during the 19th century, built with narrow head room and mezzanine floors, and hold a mere few hundred tons. Today they are useless for any form of mechanical cargo handling.

The first lesson learnt by the users of the new equipment was that they would need an entirely new type of dock shed if the potential uses of the mobile crane and the forklift truck were to be exploited. Concurrently with this came the understanding that an entirely new principle had, almost overnight, taken charge of dock work. Within living memory the ability of the port operator to handle cargo had been largely limited by the area of suitable stowage space at his disposal. Every operator had hitherto thought in terms of ground space. It was true that cargo could be piled but to do so in transit sheds was so costly that it hardly entered into the picture. Nobody thought of a shed, every inch of the floor space of which was covered with cargo, (at an average height of five feet) as being two thirds empty. The gap between the cargo and the shed roof had always been accepted as an industrial no-man's land.

The forklift truck quickly demonstrated that it could pile four pallets or more high. When the port operator contemplated a shed filled with cargo to the roof trusses, he was able to congratulate himself on doing that which none of his predecessors had ever had the means to accomplish—piling without extra cost. Area lost its value; height became the new coinage. A shed that could hold 2,000 tons deadweight of exports pitched up by hand, housed 7,000 tons when pallet piled.

This remarkable result depended however on several features:

(a) The ground floor should have a height of 20-ft. or more.
(b) Few or no stanchions should be included.
(c) Only two doors were necessary on the quay and at the rear; these must be wide enough to allow a forklift truck with a bulky load to enter; they must be 16-ft. plus high to allow a mobile crane with its jib up, carrying a load, to enter.
(d) Suspended lights, ventilators and other obstructions must be avoided.
(e) No rear or side delivery banks were required.
(f) Internal lock-ups, which should be taken up to ceiling level, could also be used for high piling, but no other of the customary buildings, such as offices, tackle sheds, lavatories etc., could be permitted inside the shed.
(g) The floor must be capable of taking a very heavy weight per square yard without subsidence.

The terrible war-time destruction, of which ports were the prime target, proved a blessing to port owners. Without the wholesale clearance of obsolete premises little of the brave new construction would have been practicable. Under the urge of the post-war boom in exports and despite crippling material shortages, the new type dock shed made remarkable progress. Even in such of the older sheds where mobile cranes could be used, it was found advisable to concrete gangways and provide aprons with hard surfaces. The whole outlook changed; only the latest and the best in shed and warehouse construction is now good enough and the shoddy, jerry-built shed that sufficed in the pre-war years is now properly recognised as industrially a dead loss, because it prohibits the modern handling of cargo.

A great responsibility has lain on those charged with the post-war re-building of the major ports. To build for the future, when the present is constantly changing, may well result only in making posterity your prisoner. Only the late war freed the present generation from the fetters riven by their predecessors, who thought that they were building for eternity.

8. **The Exchange of Vital Information**

A seventeenth century English poet said that no man is an island. Neither can a port exist unto itself alone. The efficiency of one port determines the standard of other ports. If goods can be handled cheaply and quickly at the loading port the benefit of the quick turnround is thrown away by poor handling at the discharging port. If one port is equipped to handle heavy packages much of the value of this is lost if floating derricks or other wasteful means have to be engaged before they can be discharged. This movement among the world's ports towards a higher level of efficient cargo handling is going on all the time. Of necessity this process must go on—the reverse tendency would result in a port where lackadaisical administration had allowed its entrance to silt up.

There is the need therefore for a central clearing house of technical information where the latest developments in the varied aspects of cargo handling can be co-ordinated and on whose records port operators all over the world can draw. It is only by one port knowing what other ports are doing that an overall benefit to turnround can be obtained. To take an example. In a port where timber is loaded a working stevedore has invented a new type gravity grip. With this, and some pre-shipment sorting to sizes, he is able to load his ship in much less time. For the full benefit to be obtained the stevedore entrusted with the discharge must also be converted to the use of the new equipment. In small matters such as this, as well as in the larger studies of marking, advance information, adaptation of mobile equipment to port work, the International Cargo Handling Co-ordination Association (I.C.H.C.A. as it is known all over the world) is playing an essential part. These was never a time when the efficient handling of cargo depended as it does today on the rapid dissemination of technical information.

9. **The Future of Mobile Equipment.**

Prophecy is a dangerous business; when two and two are added together in port work they rarely come to four. No one knows or can say how nuclear power will affect the design of ships or of mobile equipment. How long the conventional type of ship will survive the competition of end-loaders, hinged hatches and ramped cargo carriers is hard to say. It is a fact, however, that whilst the ship as a carrier is comparatively flexible —any entirely new form of cargo liner can be built within 12 months—ports and docks are the least flexible links in the chain of transportation. The impossibility of rebuilding these to new designs overnight may well act as a brake on changes in ship design. As we have said, the standard of the discharging port cannot be divorced from that of the loading port. The impact of change may take several decades to make itself felt on what are now regarded as backward ports. Quite a proportion of the world's tonnage is handled at open roadsteads by means which, by comparison, are primitive.

Assuming that conditions remain comparatively static for another two decades, are there immediate changes that must be contemplated in our present methods of handling cargo, if the rate of progress made during the last 10 years is not to come to an end? Many operators think there are and that many practices are already acting as a brake on further mechanisation.

It must be accepted that our present ways are rooted in a slower and more contemplative past when both time and labour were ample and when employers, particularly the dock companies, provided facilities which properly have no place in a port, essentially a transit area. Many of these facilities resulted from inter-dock competition. It is a problem that has to be faced, whether the interest of the merchant can any longer be allowed to retard the turnround of ships.

(a) **Sorting to marks, qualities, grades etc.** It has proved convenient to the consignee for these operations to be done at the time of landing.

(b) **Sampling, measuring, weighing and taring.** Once again the merchants business is facilitated.

(c) **Confusing and unnecessary marking.** For port purposes only the Bill of Lading mark and the weight is required. Sub-marks, advertisements, warning notices etc., all these impede the job of piling.

(d) **The prevalence of small Bills of Lading** (growers Bills, as they are called) in a homogeneous cargo, as opposed to the bulk shipment of carton or case traffic of similar size, weight and quality.

(e) **Simplification of customs procedure,** and documentation generally, is overdue.

These five practices are the enemies of the mobile crane and the forklift truck. As soon as sorting or samping is required, or, in fact, as soon as there is any hindrance to the even flow of cargo, costly machines, capable of moving hundreds of tons an hour, stand idle whilst a cleark fumbles with documents and good reasons are discovered for interfering with the main purpose of the port—to turn ships round quickly.

It may be argued that merchants who have become accustomed to using the ports as their own warehouses, even to the extent of turning transit sheds into long term storage premises, will not take kindly to making alternative, and probably more expensive arrangements for their retail processes. The practices listed—and every port operator will be able to add to them from his own experience—militate against mechanical handling. A point beyond which no further progress in cargo handling will be possible, however efficient the machines become, will, in present conditions, soon be reached.

Should not an attempt on international lines be made before then, to bring the leisurely customs of the past into line with the efficient practices of the future?

**Development of Port of Newcastle, N.S.W.**

The new Wickham Wharf at the Port of Newcastle, New South Wales, is expected to be completed by June this year. This wharf, which is intended to be a general purpose quay 600-ft. in length and with a depth alongside of 34-ft. is being constructed as an extension to the western end of Lee Wharf and will be equipped with two 5-ton luffing cranes. The cranes which will be mounted on tracks set in the concrete facing of the wharf, will be the first to be installed at the port. Previously all ships working general cargo have used their own gear. The total cost of the new wharf is £500,000.

When the new oil discharge berth is completed following extensive dredging in Throsby Creek, the present inflammable liquids wharf will be reconstructed as another general cargo wharf with provision for two shipping berths (Throsby berths 1 and 2). These together with the new Wickham Wharf will add 1,400-ft. of extra berthing space in the general cargo section. The oil berth to be constructed will be known as Throsby No. 3 and work will begin on it before the end of the current financial year.

An additional 550-ft. of wharf frontage has been provided at the Osborne coal handling installation on the Port River and two 9-ton electric grabbing cranes and ancillary conveyor equipment have been erected on it. These improvements have considerably assisted the turnround of ships so that 12,000 tons of cargo which formerly took a fortnight to unload can now be cleared in three days. The new plant is also handling phosphate rock imports at the rate of 150,000 tons a year.

# New Bulk Wine Berth, London Dock

An important and interesting innovation in the Port of London is the bulk wine berth at No. 22 Shed, London Dock, recently completed by the P.L.A. and now in operation.

For centuries the shipment of wine has been made in casks and this type of container, among the oldest devised, has been challenged only in recent years. With the rising cost of making and replacing casks, the wine trade has of late been turning its attention to the possibilities of bulk containers in stainless steel, plastic and other materials. By this means greater unit loads can be transported at a lower cost.

A prerequisite to meet this type of shipment is the provision, conveniently near the ship's berth, of shore-based vats or tanks into which the wine from the containers can be emptied; and the Authority met the need as it arose by providing a number of small glass-lined containers for the wine in bulk.

Early in 1958 it was decided that more substantial provision for the growing volume of wine so shipped was becoming necessary and the Authority made a detailed investigation of the needs of the trade and how its requirements at the dock side could best be met. During September of the same year many meetings were held with the dock superintendent, the wine merchants and H.M. Customs to agree the exact requirements. It was known that the wine would be shipped in bulk from the Mediterranean in 500-gallon metal containers. It was decided that the wine would be pumped ashore and stored in glass-lined reinforced concrete vats with a total capacity of 200,000 gallons.

However, storage for 60,000 gallons of wine was needed in seven months with a further 120,000 gallons storage to be ready as soon as possible. It was therefore necessary to start work on the site straight away and to work to a tight schedule. Another point to be considered was that winter was near and the building had to be erected to protect the concrete work on the large vats before frost set in. At the site chosen for the installation at No. 22 Berth on the south-east side of Eastern Dock, were the remains of a two-storey warehouse built in 1825. Most of this had been demolished by bombing during the last war and only the brick vaults remained.

Orders were placed for a tubular-framed shed clad with corrugated asbestos sheeting. As the internal temperature in the building would have to remain fairly constant, it was decided to line the walls and roof internally with fire-resistant insulation boarding. Translucent sheets were to be fitted in the roof to give natural light and controllable vents installed for ventilation.

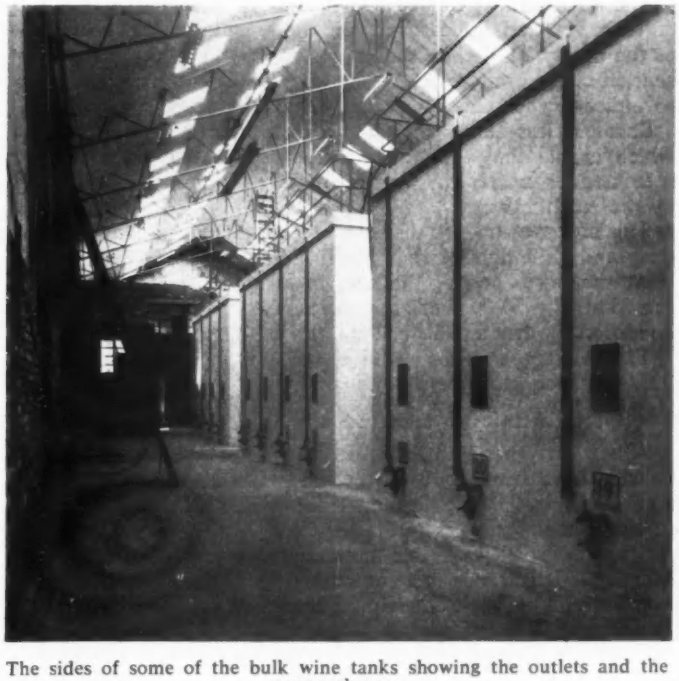
**Construction of the New Berth**

The main contractors, J. Mowlem & Co. Ltd., started work on the site in October 1958 and a large mechanical navvy began to cut into the brick vaults. Within two weeks most of these had been demolished and the large quantity of rubble removed. The site was then levelled and heavy rollers consolidated the brick hardcore foundation for the concrete floor of the new building. The column bases for the steel columns were quickly prepared and within one month from starting on the site the firm of Taylor Woodrow had delivered the steelwork and had erected the columns and trusses. After a further month the shed walls and roof had been covered with asbestos sheeting. During the erection of the shed, the building of the reinforced concrete floor and bases for the vats had been proceeding and on 13th December Borsari, Ltd., of Zurich, Switzerland, arrived on the site to begin construction of the first 40,000-gallon block of tanks.

The storage plan was to construct five blocks of vats each with a total capacity of 40,000 gallons—these blocks to be divided into seven 5,000-gallon vats and two 2,500-gallon vats. The blocks are constructed in reinforced concrete lined with glass tiles using special wine resistant cement.

Due to the mild winter weather and the hard work of all engaged on the project, the first 40,000-gallon block of vats was available in April and the second and third blocks in May and June. Due to delays in Sicily, however, the wine merchants were unable to meet the April delivery and the first consignment did not arrive until the first week in October.

Some of the tank tops at the new berth, showing the manhole covers, the pipelines and the permanent identification numbers.



The sides of some of the bulk wine tanks showing the outlets and the gauge glasses.

Satisfying all the Customs security requirements on the pipelines, vats and the buildings provided many problems but all difficulties were overcome and everything is now securely bonded. The wine in the vats is gauged by wooden dipstick rods suspended from the roof by wires over pulleys to counterweights. Specially designed control cocks are fitted on the

pipelines and to the outlets of the vats to which Customs padlocks can be attached. The pipelines throughout their lengths are visible to the Customs Officer.

To avoid contamination of the wine all the pipelines are made in stainless steel and fittings and cocks in gunmetal. In designing the pipe layout simplicity was aimed at and it is so arranged that any of the three intake points along the quay connects to its own pump (Mono type with maximum output of 3,000 gallons per hour) and thence to the overhead pipe run into any one of the 45 vats. Use is made where convenient of transparent plastic hoses or flexible sweetened rubber hose. All the main pipework, cocks, pumps and fittings were provided and installed by Farrow & Jackson, Ltd.

The wine pumps can be controlled electrically from the top of each vat and indicator lights there and on the quay face of the shed notify when the pumps are working. Signals can be sent from the craft to the inside of the shed by means of bells to indicate when the pumps are to be started or stopped.

Smaller glass-lined metal tanks are provided inside the shed which enable the wine to be pumped from the large vats in measured quantities in preparation for dispatch to the factory by the road tankers.

Special attention has been paid to the lighting; fluorescent quay and shed lighting and power points have been fitted.

At the north end of the site, in order to provide space for the 233-ft. by 50-ft. shed, the old St. George's Lock has had to be closed by driving sheet piling and filling in with hardcore.

There is space to the north of the present site for a further 200,000-gallon storage.

**Transport Facilities to and from the Shed**

A new quay has been built in the wall of which three intake nozzles have been recessed. Each connects with a stainless steel and plastic pipe leading through the quay to the tanks in the shed.

Stainless steel maritime containers, specially designed for Martini & Rossi and each containing 500 gallons of wine, arrive from Italy in vessels of the Currie Line which berth at East Quay Western Dock. The containers are transferred by barges which are berthed alongside the three nozzles. Each container in turn is connected to a nozzle and pumped dry. The total rate of discharge is 9,000 gallons per hour. When the barge has been emptied, the containers are taken back to the liner and return to Italy in the vessel in which they arrived. The value to the firm of this quick flow and return of containers is obivous.

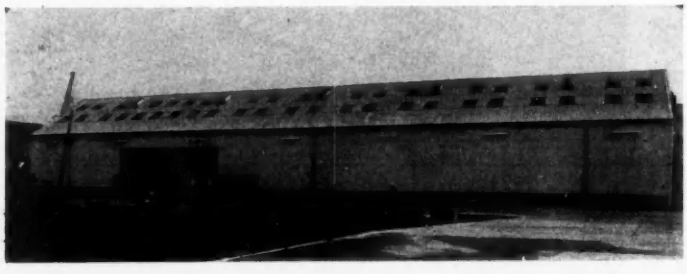
The new m.v. "Vargas" built in West Germany for the Mac-Andrew Line and the first British to be equipped with permanent tanks for the carriage of wine in bulk arrived at the London Dock last December on her maiden voyage. She has 24 wine tanks of various sizes with a total capacity of about 28,000 gallons in a special compartment. Provision has been made for the complete compartment to be placed under Customs' lock.

The steel tanks are coated internally with a wine-resistant composition and the complex pipe lines, filling and discharge cocks, etc. are of stainless steel. Pumping is by Mono pumps which are controlled by telephone from the deck and a system of bells gives a warning during loading when a tank is nearly full.

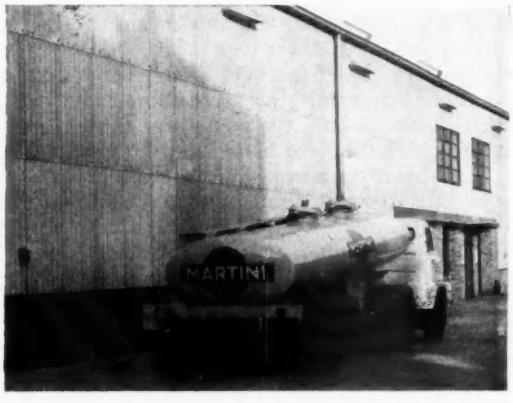
It is understood that the ship will eventually load at Tarragona, the wine being pumped in from shore installations there. On arrival at London Dock, she will lie alongside the new wine berth where the built-in pipelines will be connected to the ship.

The chain of delivery will be completed when the wine is pumped from the wine installation to a road tanker for transport to the importers' blending and bottling plant.

The installation is an excellent example of the careful appreciation of, and imaginative approach to, cargo problems now inseparable from the planning of modern dock equipment. This newly equipped berth, which when completed, will have cost in the region of £136,000, is the first in Great Britain and is expected to effect a considerable saving in handling costs. 200,000 gallons of wine would need some 4,000 casks to contain it. Instead of landing the casks, setting them up for gauging and rolling them to a crane for delivery, only pumping is involved. In store the casks would require constant supervision by coopers to guard against leakage. By handling in bulk one man with two assistants controls the whole operation.



(Above) Exterior of the new Bulk Wine Berth at the London Dock. The barges alongside are loaded with the first consignment of Maritime Containers.




(Right) Martini and Rossi's road tanker taking delivery of bulk wine from the tanks of the new berth.

## New Passenger Terminal for Port of Sydney

Some unconventional practices, as far as Australia is concerned, have been introduced in the design and construction of the new passenger terminal now being built at the Port of Sydney.

The superstructure rests on a solid foundation instead of on piles as is normally the case. A 700-ft. long sea wall has been built of reinforced concrete caissons, and the area behind it filled with sand dredged from the harbour bed. There is a minimum depth of 35-ft. of water at the wall. Although the superstructure is modern in character, it has been designed to blend with neighbouring buildings. Glass and aluminium are being used extensively, and the conventional pitched roof will give way to a wing-shaped covering sheathed in aluminium and supported on steel frames.

There will be three levels. Cargo and baggage, etc. will enter and leave vessels at ground level; passengers will join and leave vessels at the first floor; and a mezzanine floor will provide amenities and office accommodation. The whole building will be 625-ft. long by 111-ft. wide. It is estimated that the terminal will cost A£2,500,000, and it is expected to be completed by the end of 1960.

# The Surfacing of Wharves, Roads and Warehouse Floors in Dock Areas

## General Considerations affecting Choice and Type of Materials

By LEO CRYSTAL, B.Sc.(Eng.), A.C.G.I., A.M.I.C.E.

The surfacing of wharves, quays and dockside areas is the concern of both the commercial and engineering sides of Port Management. Whatever the layout, or structural design, of the quays, a decision must be made on the type of surface to be used and the variety of roads and wharf surfaces found in dock areas reflect the attempt of Dock Engineers to satisfy and combine the requirements of operating and traffic departments and the, frequently conflicting, site conditions obtaining.

Generally speaking, the operating departments call for efficient transport routes in and about the wharves, and well surfaced quays and marshalling areas; all of which must be designed to meet a multiplicity of cargo and traffic conditions. At the same time, the initial cost of new works and the maintenance charges of existing surfaces cannot be overlooked so that frequently, as in many other matters, a compromise solution may often be the result.

This article has been written to provide general information to Dock users on the various road surfaces available and to give some details of their design and construction, so that those concerned with such matters may have a clearer appreciation of the factors involved in their choice and the means available to satisfy their requirements.

The article is written under the following heads:

1. Definitions.
2. General considerations affecting choice of surface.
3. Particular needs according to locale.
4. Types and general description of surfacing materials.
5. Site conditions.
6. Pavement design.
7. Maintenance and renewals.
8. Specifications.

### 1. DEFINITIONS

Before considering the various types of surfacing, it is well to have an understanding of the terms applied, in road engineering, to component structural parts of a pavement.

The term "pavement" is used to describe the overall construction above formation level and Fig. 1 shows the basic form of construction and the related terms which will be used in this article.

Each type of surface may have several suitable but alternative forms of base course and consideration of these is made later.

### 2. GENERAL CONSIDERATIONS

#### Surfacing

The choice of surfacing depends on a number of factors.

Firstly, there is location. The dock area may be divided into five typical areas, each having its own particular requirements, and each being satisfied by a type of surface which is independent of those selected for the other areas. These typical areas are:

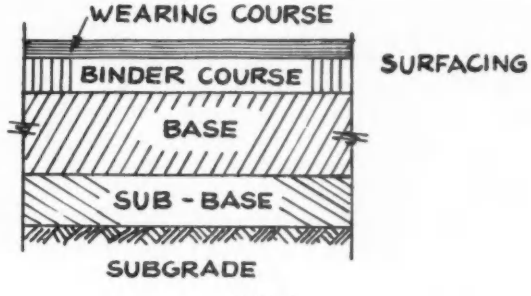
1. Wharf apron and quayside areas.
2. Marshalling areas, including open storage areas.
3. Through traffic routes.
4. Minor traffic routes and thoroughfares.
5. Wharf sheds and warehouses; ground and upper floors.

Secondly, is the traffic moving on the surface of the pavement. This will include the nature and density of the traffic and type or types of mechanical handling gear.

The third consideration is the type of commodity or goods predominantly handled on the paving and whether passenger traffic has to be considered.

Fourthly, are the over-ruling site conditions, such as foundation characteristics, the existence or otherwise of rail tracks, oil, electrical and water supply ducts and mains, drainage facilities and requirements, and the like.

The first two factors—location and traffic—are generally interrelated whilst the third and fourth—goods and site conditions—are likely to vary widely and be the deciding factors in the type of surfacing chosen.




NOTES

(1) The sub-base can be omitted if the subgrade quality permits.
(2) The base can be a granular or stone pitched course, or a concrete slab.
(3) The surfacing can be a one or two course bituminous mixture.
(4) If the base is a concrete slab the surfacing can be omitted or be a special screed.

Fig. 1. Structural component parts of pavement.

### 3. PARTICULAR NEEDS ACCORDING TO LOCALE

The particular characteristics of the five typical areas mentioned above which affect the choice of surfacing are:

#### Wharf Apron and Quayside Areas

The surfacing medium is subject to heavy localised loads, impact, sliding and abrasive forces induced by the use of mobile handling gear with steel shod wheels or tracks, chains and cargo handling equipment. Some cargoes, such as chemicals and ores, may result in materials, deleterious to the surface, coming into contact and contaminating it, whilst scoring of the surface may be caused by steel sections being dragged over it. In addition, being relatively near to the water's edge, the surface should be capable of withstanding the alternate wetting and drying action that will occur as a result of spray and wind.

#### Marshalling Areas

The term "marshalling areas" is used to cover those areas in the rear of wharfs where road transport, incoming and out-

going, loaded and empty, is parked prior to being called on to the quays or commencing their journey out of the dock. It also covers areas set aside for reception of large indivisible or bulky loads and what are sometimes known as "hardstandings."

In these areas the surfacing must withstand deformation under heavy, concentrated, static wheel loads, wear due to acceleration and braking, and resistance to oil and petrol droppings from the vehicles.

**Through Traffic Routes**

These are the main road thoroughfares into and out of the docks and assume the same importance as do the main roads in any industrial area.

The surface is subject to heavy loads under very dense traffic conditions and at the same time should present such traffic with a good running surface, free from irregularities and well drained.

**Minor Traffic Routes and Thoroughfares**

In this category are the roads and passageways for cars and pedestrians within the dock area that are not a through traffic route or marshalling area.

The surface is subject to light vehicular and foot traffic.

**Wharf Sheds and Warehouses**

Single-storey transit sheds and the ground floors of warehouses generally require a surfacing able to withstand deformation under concentrated loads and wear due to mechanical handling equipment and vehicular traffic. The surface must be level and suitable for the type of goods stored, must not sweat nor take up or exude smells. The surface should not generate its own dust and should be smooth enough to allow adequate cleaning and washing to be carried out.

On the upper floors of warehouses, the surfacing, in addition to the foregoing, is required to protect the structural floor and must be capable of maintenance, repair and renewal without damage to the structure.

## 4. TYPES AND GENERAL DESCRIPTION OF SURFACING MATERIALS

The main types of surfacing materials are:

Concrete.
Bituminous surfaces.
Stone setts.
Timber
Steel.
Specialist surfacings which are generally proprietary are also available in one or more of these materials.

**Concrete**

The advantages of a concrete surface are:

(a) It is non-skid and can be made to have a fairly abrasive resistant surface, although these qualities are dependent on the use of selected aggregates and good mix control.
(b) It has good light reflecting qualities but this factor is only of value where brilliant sunlight does not obtain or where night working and artificial lighting are frequently in practice. In brilliant sunshine areas the use of pigments to colour the concrete may be resorted to, in order to reduce glare from the surface.
(c) Ease of initial placing by relatively unskilled labour using fairly inexpensive plant.
(d) It is reasonable in first cost.
(e) Large areas can be covered rapidly, especially by using a grouted aggregate process (see Figs. 2 and 3).
(f) For the floors of upper storeys of warehouses, the constructional material, which is often concrete, can be left for use as the finished surface, though possibly with a granolithic finish.

Fig. 2. Port of Aden. Quay paving under construction using "Colcrete."

The disadvantages of a concrete surface are:

(a) There is at least a week's delay between laying the surface and opening to traffic, unless special cements are used.
(b) The surface is particularly vulnerable to loads or blows which cause indentations; unless remedial measures are put in hand, pot holes can rapidly develop from this type of damage. The repair of this type of damage or, indeed, any patching of a concrete surface is troublesome and never wholly satisfactory.
(c) A system of joints must be adopted to allow for expansion and contraction of the paving. At the same time measures must be adopted to guard against unequal or uneven settlement of the individual slabs.
(d) Unless special measures are taken the surface can be very dusty under wear.

A concrete surface requires a well constructed base course and should itself be not less than six inches in thickness. For heavy duty a dense mix of high strength with rounded or other special aggregates is required although a substance for hardening

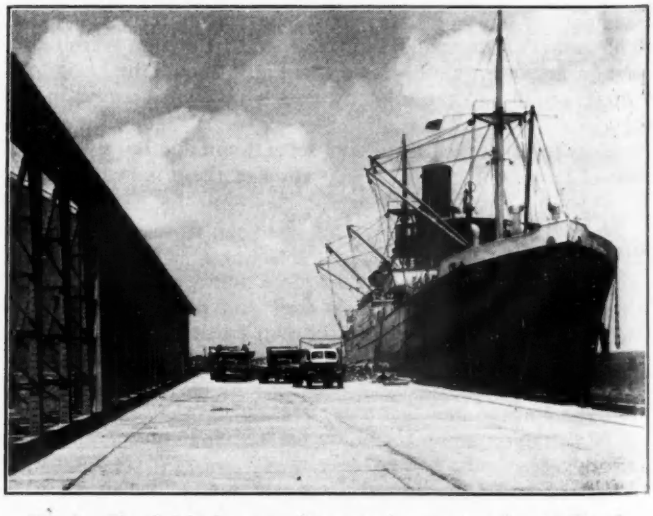


Fig. 3. The finished quay—shown under construction in Fig. 2.

c. reinforcing the surface is frequently used.

Of the surface hardeners, silicate of soda P.84 applied to the dry concrete surface is a typical example, but there are other proprietary preparations which are extensively used for this purpose.

Reinforcement of the actual surface can be carried out by adding a hard wearing layer to the concrete surface during construction or incorporating steel wearing strips or surface plates.

There are a number of substances with which this hard layer can be obtained, generally by the use of iron filings or special mineral aggregates. These are applied to the surface, either as a cement slurry during construction or trowelled in to the green concrete. The resulting surface is effective but due to corrosion, when iron particles are used, the appearance of the slab sometimes suffers. There are many proprietary brands of surface hardeners available.

Steel or iron surfacing plates are available. These consist of pressed steel or cast iron perforated plates 12 inches square with suitable anchors which are laid as tiles on the surface of the concrete slab during construction. They are very durable but expensive and the former can become slippery.

A refinement of the concrete surface is the raft slab by Stelcon. A typical installation is shown in Fig. 4. This pavement consists of precast reinforced concrete slabs with a special heavy duty surfacing which can be either of a steel or mineral aggregate. The slabs are bound with angle iron and are suitably reinforced. They are laid on a sand bed and can be lifted and relaid to accommodate settlement of the foundation. Special units are used to accommodate rail tracks. The units are handled by a mobile crane and only a small semi-skilled team is required to ensure a reasonable surface finish.

Fig. 4. Typical installation of Stelcon Raft Paving at Newport Docks.

**Bituminous Surfaces**

A bituminous surface is one in which the agglomerating property of a bitumen or tar at atmospheric temperature is used to bind coarse and fine aggregate together to form a firm dense material capable of resisting deformation under load.

The advantages of a bituminous surface are:

(a) The thickness of the surfacing can be easily varied to suit changing load and foundation conditions and in remedial work a good bond between old and new work, with only a small thickness of the latter, can be obtained.
(b) Expansion joints are not normally required and a clear regular surface is obtained.
(c) The surface does not, of itself, raise dust.
(d) The texture of the surface can be varied within fairly wide limits, to suit the type of traffic. For example, at the slight ramp that often exists at the entrance to transit sheds a rougher surface can be imparted to the basic material of the shed floor.
(e) The surface can be made resistant to deleterious chemical attack and abrasion.
(f) The surface can be opened to traffic within a few hours of placing.

The disadvantages of a bituminous surface are:

(a) A rigid control is required over the specification of the binder to accord with the temperature and humidity conditions obtaining on the site as well as having regard to the traffic to which the surface is subjected.
(b) Expensive plant and skilled labour is generally required, especially in the hot-mix type of surface, and also where rapid coverage is required.
(c) Poor light reflection although this can be an advantage in areas of brilliant sunlight.

Bituminous surfacings, because of the great variation that can be obtained, need careful consideration and this subject is therefore treated in more detail in the following paragraphs.

In the descriptions the following definitions apply:

(a) **Straight-run bitumen:** A bitumen prepared from derivatives of natural hydrocarbons by distillation, and substantially soluble in carbon disulphide; sometimes called Residual Bitumen.
(b) **Lake asphalt:** Natural or naturally occurring bitumen existing as a viscous fluid and containing inert mineral matter.
(c) **Cut-back bitumen:** A straight run bitumen which has been thinned down or " cut back " with a volatile flux.
(d) **Asphaltic cement:** Straight run bitumen or the product resulting from a mixture of lake asphalt and bitumen or lake asphalt and flux oils, producing a binder having cementing qualities suitable for road surfaces.

Types of surfacing in which bitumen is the binder are:

Rock asphalt.
Rolled asphalt.
Mastic asphalt.
Bitumen macadam.

and those for which tar is the binder:

Tar macadam, in base or wearing courses.
Tar carpets.
Dense tar surfacings.

All the above surfacings, with the exception of Dense Tar surfacings, are covered by British Standards which, in addition to providing guidance in the choice and proportions of binder and stone, specify the characteristics of the binder as well as recommend temperature ranges within which mixing and laying should take place. Reference is made to these later.

British Standards do not specifically apply to floors and pavings subject to particularly onerous duties and it is this latter type of paving that is the province of the specialist contractor, as well as being the concern generally of engineers and others responsible for the provision and maintenance of surfaces in dock areas.

The basic principles, however, do not materially alter and a general description of the various types is as follows:

**Rock Asphalt**

Consists of powdered natural rock asphalt which is heated, spread and compacted on a prepared surface. The surface of the asphalt can receive an application of stone aggregate coated with bitumen.

**Rolled Asphalt (sometimes called Asphaltic Concrete)**

Consists of stone and sand aggregate, heated and mixed together with an asphaltic cement and filler. The asphaltic cement is either a straight run bitumen or a fluxed lake asphalt.

The coated aggregate is laid on a prepared surface and compacted by rolling. It may be placed in one or more courses, as may be required. The texture of the surface depends on the size of aggregate, which is chosen according to whether the material is laid in a base or wearing course.

**Mastic Asphalt** (see Fig. 5)

Mastic asphalt is formed from asphaltic cement and filler, mixed with fine aggregate in a special hot-type mixer and laid by hand while hot. The surface is finished with a wooden trowel; an indented roller may be used to impart a "texture" to the surface. The asphaltic cement can be a residual bitumen or lake asphalt or a mixture of the two.

**Bitumen Macadam** (see Fig. 6)

This is similar in composition and manufacture to rolled asphalt but with a much reduced fine aggregate content. The binder is a straight run or cut-back bitumen. The surface generally requires a sealing coat of bitumen coated grit or fine sand.

**Fine Cold Asphalt**

Fine cold asphalt consists of a fine crushed aggregate coated with bitumen. It usually has a low viscosity binder, and can be laid hot or can be stored for use as required and laid cold. Because of this property and its aggregate size, it is mainly used for resurfacing existing surfaces, such as worn concrete and macadam roads and stone setts. It is frequently used as a thin carpet in surfacing passageways, pavements and platforms.

**Tar Macadam and Tar Carpets**

Consist of a stone aggregate hot-mixed with a tar binder and filler. The aggregate grading is varied according to the thickness and type of surface, whether base or wearing course.

**Dense Tar Surfacings**

Consist of stone and sand aggregate heated and mixed together with a high viscosity tar and filler. It is the counterpart of rolled asphalt but with use of tar or a tar-bitumen mixture as a binder.

The crux of the difference of any of the previously described surfacings is in the asphaltic cement or binder used. The most durable bituminous surfaces consist of dense voidless mixtures which in order to resist deformation under traffic require a hard binder.

Fig. 5. Ground floor of mastic asphalt in transit shed at Liverpool.

The hardness of the binder is specified in two ways. In the case of tar or cut-back bitumen it is given in terms of viscosity measured in a standard viscometer, or as an equi-viscous temperature. In the case of straight-run bitumen or lake asphalt it is measured by the standard penetration test. The lower the penetration the harder the bitumen.

The essential characteristics of the binder must be that at normal temperatures it is hard and durable, that it does not soften at the highest likely temperature to be attained, or that it becomes too brittle at the lowest likely temperature. It is the specifying of the characteristic of the binder which calls for great judgment and experience. In addition, the amount and grading of any filler which is added to any asphaltic cement to form a mastic is also of importance since the laying characteristics of the material are affected; to much filler causes the mastic to be doughy and too little will cause it to be harsh, resulting in a poor finish to the pavement.

It is possible to obtain a pre-mix mixture using hot bitumen and cold stone; the bitumen being a suitable cut-back type, but this type of mixture is not as suitable as the hot mix type for heavy duty surfacing.

One of the specialist type of bituminous surfacings available is known as Lithocrete. This form of surfacing, which is a proprietary product of the Limmer and Trinidad Lake Asphalt Co. Ltd., is the specialised road surface recommended by that firm for use in dock areas. It is essentially a mastic asphalt in which the binder or asphaltic cement is a lake asphalt (possibly fluxed) with a penetration number suitable to the conditions obtaining. The specifying of this detail and the filler content in effect constitutes that firm's particular trade brand of surfacing. This type of surface is widely used, especially in transit sheds (see Fig. 5).

**Bitumen Emulsions**

As an alternative to the foregoing hot-mix bituminous mixtures it is possible to use a pre-mixed bituminous compound which can be laid cold. This type of mixture has many advantages not least in that no plant is required beyond a roller and rakes and no great skill is required to lay it. The binder is added to a mixture of sand and stone and the whole mixed to a uniform colour and homogeneity. Normal Portland cement is sometimes added as a filler. The mixture is laid by hand between screed boards of the correct thickness and tamped. It is finished by floating and rolling but requires a few days' curing to become properly set. There are several proprietary brands of bitumen emulsion on the market, and much experience has been gained in their use. Flintkote Mastic Flooring has been widely used for many years in this field under a variety of traffic and climatic conditions.

**Sand Bitumen Carpets**

A very useful and cheap form of surfacing can be used on areas of reclamation, after the initial drying out and settlement, provided the reclamation is a reasonably well graded sand. The sand is mixed with a cut-back bitumen either by ploughing in place or, preferably, in a paddle type mixer—the sand bitumen carpet being placed in layers of consolidated thickness of 2 to 4-in. The pavement can be built up of any desired number of layers and the surface is given a wearing coat of bitumen coated chippings rolled in.

**Surface Sealing Coats**

The use of sealing coats is resorted to, to seal surfaces of worn bituminous surfaces. Such coats can also be used as a cheap form of surfacing when spread over properly prepared base courses and as such are useful on "hardstanding" or similar areas. The sealing coat is formed by spreading and rolling gravel or crushed rock chippings on to a spray coat of bitumen and can be repeated where two-coat work may be desired.

**Grouted Mixtures**

This material is formed by placing and compacting stone aggregate and binding the mass together by applying bitumen over the surface and rolling in stone chippings. The surface which results

is only suitable generally for lightly trafficked roads but the method is useful for foundation construction.

**Rubberised Asphalt**

A development which has taken place within the last ten years is the use of rubber as an additive in bitumen mixtures. The desirable properties which, it is claimed, the addition of rubber imparts to a bitumen surface are:

(a) Rubberised bitumen is less brittle and has improved resistance to impact and skidding.
(b) It is tougher and more extensible and therefore resists cracking.
(c) It has reduced temperature susceptibility.

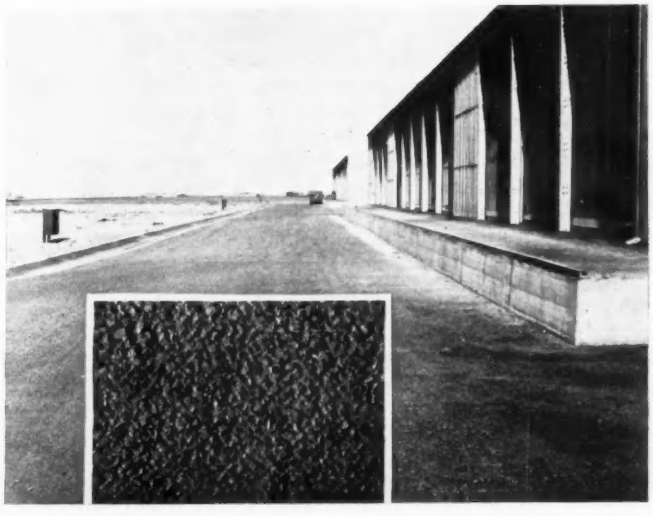


Fig. 6. Bitumen Macadam service road at rear of transit sheds, Port of Aden. (Inset: surface texture before sealing.)

**Stone Setts**

This type of paving is very common in dock and other heavy industrialised areas.

The advantages of this type of paving are:

(a) An abrasive and impact resistant surface.
(b) The surface is easy running to iron-tyred trucks, provided that the surface is regular.
(c) The setts themselves have a long life.

The disadvantages of this type of surfacing are:

(a) The initial cost is high and skilled masons are required for cutting the setts and laying them.
(b) Difficult to work on once the surface has become irregular.
(c) Causes damage to vehicles and plant by vibration and shock.
(d) Inclined to generate its own dust.

The type of stone is important as some setts become very slippery requiring surface treatment to roughen them. Setts can also become very irregular in wear resulting in a very uneven surface.

Stone setts have in the past been very much used in the surfacing of quay and dockside areas, especially where iron shod trucks and wagons were to be found.

They are excellent for the purpose if made from hard medium grained igneous rocks and properly and evenly laid. In view of the generally high initial cost of the setts and the skilled labour required in laying and maintaining them to a regular surface, they do not find favour to-day.

**Timber**

The advantages of timber surfaces are as follows:

(a) Efficient and convenient for use in wharf sheds where the upper floors are part of the construction.
(b) Warm and dust-free.
(c) Does not absorb the smell of merchandise.
(d) Where timber is plentiful the material is a cheap, reliable and efficient form of construction.

The disadvantages of a timber floor are:

(a) Lack of durability for heavy cargo work.
(b) Relatively high resistance to hand trucks.
(c) Liability to splinter. This is a particular menace to labour in hot countries where workmen do not always use footwear.
(d) Susceptibility to the hazard of fire although chemical protective coatings and injections may reduce this risk.

**Steel**

Steel surfacing is usually found in the form of chequer-plate covering to walkways, gangways and in the coverings to ducts. It is also used with a concrete backing in the form of slabs and plates which have been mentioned in the section dealing with concrete surfaces.

The advantages of steel are:

(a) Its resistance to rough working.
(b) Its resistance to oil and other deleterious materials and to abrasion.
(c) Its long life, provided reasonable protective measures are taken.
(d) Its incorporation as a structural material in buildings.

The disadvantages of steel pavings are:

(a) Hard underfoot and possibly fatiguing to labourers.
(b) Excessive gain in temperature if exposed to the direct rays of the sun, with discomfort to workmen.
(c) Anti-corrosive measures are generally necessary and these are frequently expensive.

In addition to the fixed type of steel plate are "slick" plates. These are mild steel plates which are placed on the quay surface below mineral stacks to facilitate loading operations by mechanical shovel or scoop.

*(To be continued)*

## Book Review

**Cathodic Protection: Its Theory and Practice in the Prevention of Corrosion.** By John H. Morgan, M.A., A.M.I.E.E. Published by Leonard Hill (Books) Ltd., London (57s. 6d.).

This book has the distinction of being the first comprehensive text-book on cathodic protection in the English language. Describing cathodic protection, the Foreword states "The beautiful simplicity of the principle on which it operates is in contrast to the complexity of the technique . . . . cathodic protection offers the possibility of perfection, of complete freedom from corrosion; and this not merely as a theoretical ideal, but as a practical target".

The first five chapters describe the technique of cathodic protection, including an elementary treatment of the electrochemistry of the metal/electrolyte interface, practical parameters, resistivity and resistance, sacrificial anodes and impressed current. The next three chapters apply these principles to the protection of buried structures, of structures in sea water, with a short treatment of fresh water, and of structures containing electrolytes. The final chapters deal with interferences, instruments and economics.

Explanation of the techniques employed in cathodic protection is the justifiable claim of this book; it wisely disclaims any intention of being a do-it-yourself manual. Present-day delays in publication are such that no book dealing with a branch of science in its most vigorous stage of growth can hope to present the most recent discoveries; in a very few instances the informa-

tion given by the author is not complete. The only serious fault is in the case of lead alloy anodes, which are now known to be unsuitable for installation in mud. Sometimes the author's meaning is obscure: for example, ref. page 224, why should a flameproof transformer/rectifier be employed for impressed current protection of a sea water storage tank? Again, he would appear to be optimistic in some of his practical designs—the anode mountings shown in figs. 138, 139 and 140 would be liable to fatigue failure in turbulent flowing water.

The theoretical treatment in the first five chapters is excellent as also is the concise information on sacrificial anodes and groundbed design. The chapters on applications to structures are a good guide to the technique, provided they are treated as a guide and not as working instructions. Stray current, interference and instruments are treated comprehensively. The final chapter on economics breaks new ground in estimating the lowest overall costs of working installations, instead of, as is more usual, attempting to guess the probable savings due to cathodic protection; this chapter is excellent.

The book is well arranged and illustrated, with 189 figures and 30 plates; the generous use of sub-headings assists easy reading. The references at the end of each chapter, which, of course, do not include work published more recently than 1958, would be improved by number references in the text.

It is regrettable that 325 pages selling for 57s. 6d. are printed on matt paper. If the book is used as frequently as it deserves it will soon become unsightly.

Mr. Morgan's book should be read by everybody interested in cathodic protection. His first attempt fills a real need and he should be encouraged to prepare a second edition in the near future. E.D.D.

## Obituary

It is with deep regret that we record the death on January 28th last of **Mr. A. C. Hartley,** C.B.E., B.Sc.(Eng.), M.I.C.E.

Arthur Clifford Hartley, the son of a Hull surgeon, was born on January 7, 1889, and, after a general education at Hymers College, Hull, he began his engineering studies in 1906 at the Hull Technical College, later continuing at the Imperial College of Science and Technology, the City and Guilds (Engineering) College, London. In 1910, he obtained his A.C.G.I. and graduated a B.Sc.(Eng.), London University.

Mr. Hartley then became a pupil of the late Mr. T. M. Newell, M.I.C.E., Chief Engineer of the North Eastern Railway, Hull Docks, and until 1912 was engaged upon designing and superintending works at the Company's docks at Hull, Hartlepool and Middlesbrough. Afterwards he obtained further engineering experience with Rose, Downs and Thompson of Hull, and with the Limmer and Trinidad Asphalt Company.

During the 1914-18 war, he was commissioned into the Royal Flying Corps and and later the Royal Air Force. He obtained his "wings", was promoted substantive Major, and awarded the Military O.B.E. and twice Mentioned in Despatches. He was responsible for the development of the Constantinesco synchronising gear to enable machine guns to be fixed between the blades of tractor aircraft propellers.

From 1919-1924, he was a Partner in the Consulting Engineering firm of Maxted and Knott, specialising in the design and erection of cement works.

Mr. Hartley began his long association with oil engineering when he became Assistant Manager in the Engineering Dept. of the Anglo-Persian Oil Company in 1924. In 1934 he became Chief Engineer of the Company—then the Anglo-Iranian Oil Company—and held that post until his retirement in 1951. After his retirement he was in private practice, and also a Consultant to Messrs. Rendel, Palmer and Tritton.

During the 1939-45 war he worked on the development, in 1940, of a stabilised automatic bomb-sight, and in 1942 made the suggestion which led to the development of the "Pluto" oil pipeline across the English Channel, for which he then became responsible. Later in 1942, he was appointed Technical Director to the Petroleum Warfare Dept. and was responsible also for the "Fido" airfield fog clearance system, and for flame weapons. He was awarded the C.B.E. in 1944, and the U.S. Medal of Freedom for his work in connection with "Fido".

In his connection with the Institution of Civil Engineers, Mr. Hartley was elected Associate Member in 1916 and was transferred to the class of Members in 1928. He served as a Member of Council from November 1946 to November 1951, and from November 1952 to November 1955, in which month he was elected Vice-President. In November 1959 he took office as President.

In 1936 he became a Fellow of the City and Guilds of London Institute, and in 1953 an Honorary Fellow of Imperial College. He was elected President of the Institution of Mechanical Engineers in 1951. Among other positions he held was Vice-President of the Institute of Petroleum, whose Redwood Medal was awarded to him last year. He has also served as a Member of the Council of the Royal Society of Arts, and as a Manager of the Royal Institution.

Mr. Hartley was well known for his Papers and Lectures to various Institutions and his contributions to the technical press.

## Retirement

**Mr. W. Mackenzie,** M.I.C.E. has recently retired from the Board of Management at British Transport Docks and from his position as Engineer (General Duties) to the Board.

Mr. Mackenzie graduated as B.Sc. in engineering at the University of Edinburgh in 1907. He joined the staff of Rendel and Robertson, Consulting Engineers, Westminster, and was engaged on dock and harbour construction work in Scotland. In 1911 he was appointed as an Assistant Engineer with the Port of London Authority at Surrey Commercial Docks, and in 1912 was posted to Tilbury Docks as Assistant Resident Engineer on the major contracts for the main dock extension and the construction of the deep water river cargo jetty.

In 1914 Mr. Mackenzie became Resident Engineer at Tilbury Docks and was also placed in charge of the construction and subsequent maintenance of a floating bridge across the Thames between Gravesend and Tilbury, which was completed in a month by the Port of London Authority for the War Office. In 1920, he was appointed Resident Engineer at the Royal Docks.

In 1926 the Port of London Authority embarked on a programme of major improvement schemes at India and Millwall Docks and at Tilbury Docks. Mr. Mackenzie was appointed Resident Engineer for the works which were completed in 1930. A year later he joined the London and North Eastern Railway as Chief Assistant Engineer for Docks, and in 1947 was appointed Chief Engineer for Docks, with responsibility for the Company's Docks at Hull, Grimsby, Immingham, Hartlepools, and Middlesbrough.

When the railways were nationalised in 1948 these docks passed to the control of the British Transport Commission. In 1952 Mr. Mackenzie was appointed Engineer (General Duties) and three years later he became a Member of the Management Board for the Commission's Docks, acting in an advisory capacity to the Board in connection with the many improvement schemes which have been embarked upon at various ports.

Mr. Mackenzie has taken a great interest in the Permanent International Association of Navigation Congresses, which is concerned with canals, inland waterways, ports, and harbours and is supported by the governments of some 50 countries. He was appointed Secretary General of the 1957 Congress in London

# The Channel Tunnel Project

## An Account of the 1959 Sea Bed Investigations

By M. J. TOMLINSON, M.I.C.E., A.M.I.Struct.E. and R. F. HEYNES, B.Sc.(Eng.), A.M.I.C.E.

SEA bed investigations were undertaken in the 1959 season for the Channel Tunnel Project. These provide an interesting example of the adaptation of site investigation methods used for docks and harbours and other shallow water civil engineering works to operations in deep water at a considerable distance from the shore. Conditions in the Straits of Dover with a high tidal range, powerful currents, a rocky sea bed and crowded shipping lanes combined to make this a most difficult marine drilling operation.

The Channel Tunnel scheme has, of course, a long history of exploration and of fluctuating fortunes. In 1802 the French engineer Mathieu put forward the first Channel Tunnel scheme to Napoleon. The latter was heavily involved in preparing for war, so the scheme was dropped.

Over half a century elapsed before the next serious tunnel scheme was produced. In 1856, the year of Victoria and Albert's state visit to France, de Gamond presented his scheme to the Emperor Napoleon III. There was much enthusiasm for his scheme on both sides of the Channel. Unfortunately an attempt on the life of the Emperor in 1858 resulted in a deterioration of relations between England and France. The result was that de Gamond's scheme was also dropped. Sir John Hawkshaw made, in 1865, an important English contribution to the study of the engineering problems of the tunnel. This consisted of soundings, and boreholes on both sides of the Channel to check the levels and thicknesses of the different beds of rock.

After a further proposal had been baulked by the onset of the Franco-Prussian war of 1870-71, a period of activity ensued. The French geologist de Lapparent carried out a programme of sea bed sampling and soundings in 1875-6. In the early 1880's a pilot tunnel 7-ft. in diameter was driven over 2,000 yards towards France from a shaft sunk at Shakespeare Cliff. A second tunnel from a shaft at Abbotts Cliff was taken 800 yards. By this time, however, public feeling turned against the concept of a cross-Channel Tunnel. The main argument used was that the tunnel would expose England to sudden invasion. This and various other objections thwarted subsequent attempts to revive interest in the tunnel. The consequence was that the overall progress in the last seventy years has been negligible; only in the last few years has real interest been revived.

On 26th July, 1957 the Channel Tunnel Study Group was formed from English, French and American interests. Its purpose was to study further the engineering and economic possibilities of a Channel Tunnel. Preliminary investigations comprising boreholes on land, a geophysical survey and pumping out and examining the experimental shaft at Sangatte were undertaken in 1958.

### Scope of 1959 Investigations

Early in 1959 the Channel Tunnel Study Group invited international tenders for an investigation of sea bed conditions by means of borings in the Straits of Dover. The contract, which was awarded to the Wimpey Central Laboratory, was subsequently extended to cover geophysical surveying and other work.

Site work, which commenced in April 1959 and was completed in the following October, comprised four main operations:

(a) Sinking eight boreholes into the sea bed at various points across the Channel.
(b) Taking a large number of samples from the sea bed to establish the location of the outcrops of the various geological formations.
(c) Establishing the structure of the geological formations below sea bed by geophysical methods using the Continuous Stratification Recorder (Sparker) equipment.
(d) Sinking a borehole on land in Dover Harbour.

The main object of the work outlined above was to obtain information on the location of the outcrops and the dip of the geological formations which extend from Dover to Sangatte. The main formations beneath the Channel are, in descending order:

Upper Chalk
Middle Chalk
Lower Chalk
Glauconitic Marl
Gault

All the above strata outcrop in the area of the investigations and they dip towards the north east. Over most of the area the strata are exposed on the sea bed, but at various places, notably in mid-Channel, they are concealed by deposits of sand and gravel.

The sequence of the 1959 investigation was firstly to get a general picture of the structure and in particular the dip of the chalk formations by geophysical methods; then to map as accurately as possible the outcrop of the Lower Chalk. Finally it was necessary to check the interpretation of the geophysical survey by precise location of the interfaces between the Lower Chalk, the Glauconitic Marl and the Gault by deep boreholes sunk down dip from the outcrops. A further object of the borings was to obtain cores to assess the engineering characteristics of the rocks, and to assess the permeability of the rocks by in-situ tests.

### SEA BED BOREHOLES

#### The Boring Vessel

Owing to the depth of water at the borehole positions (maximum 155-ft.) the boreholes were sunk from a floating craft. It was considered that this method offered several advantages over

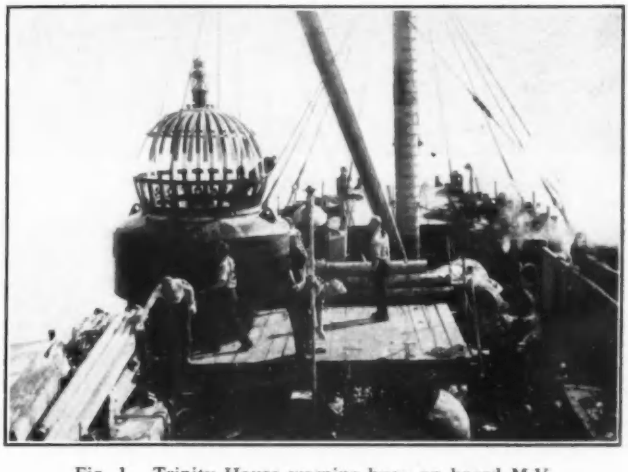


Fig. 1. Trinity House warning buoy on board M.V. "Ian Salvor III".

attempting to drill from a tower resting on the sea bed. The Wimpey laboratory had developed the floating vessel technique during the course of many marine site investigations in U.K. and overseas, including drilling boreholes 70 miles offshore in water up to 180-ft. deep in the Persian Gulf.

The selection of a suitable craft called for some care. Essential requirements of the craft were steadiness in moderately rough sea conditions, good mooring and lifting facilities and adequate accommodation for boring crews working round the clock.

Fortunately the Wimpey Central Laboratory had just previously completed successfully a series of offshore boreholes at Dungeness, some miles to the south west of Dover. These boreholes were sunk during the period January to March 1959; the boring craft used on this occasion, often in adverse weather conditions, had proved most suitable. It was decided that the vessel would meet satisfactorily the requirements of the Channel Tunnel investigation, and this proved to be the case.

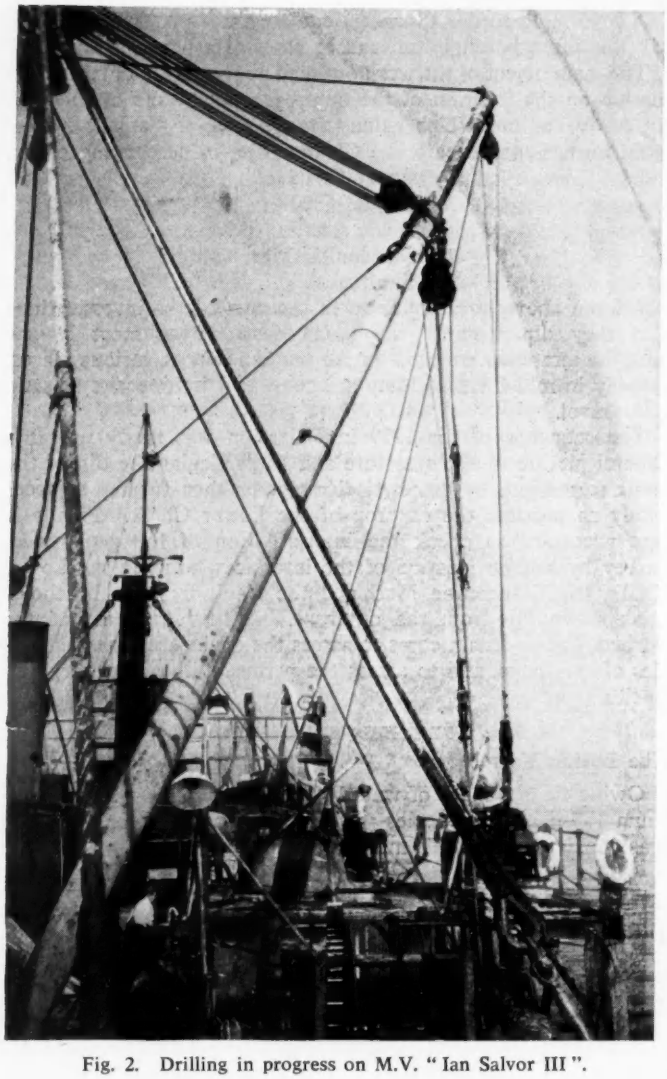


Fig. 2. Drilling in progress on M.V. " Ian Salvor III ".

" Ian Salvor III " is a Mark IV L.C.T. owned by the Gray and Thomson Salvage Co Ltd. of Felixstowe. It has been converted by the owners for use as a salvage vessel. Overall dimensions are 187-ft. length, 40-ft. width, and a mean draft of 5-ft. Excellent mooring and lifting gear are installed on the vessel, together with welding gear and diving equipment. As would be expected on a salvage vessel the main derrick has a good rated capacity (20 tons) and this proved invaluable. Other installations include a Decca Navigational Aid System, radio telephone, and an echo sounder.

Fig. 3. (above) Core of chalk being extracted from core barrel.

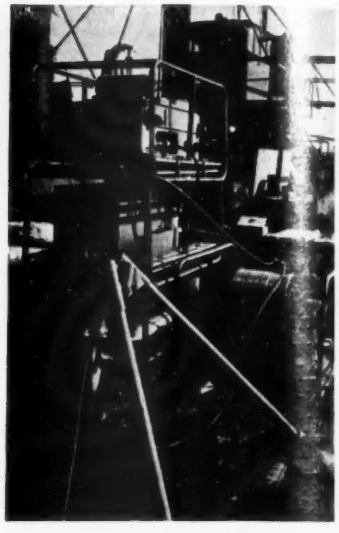


Fig. 4. (right) Schlumberger portable well logging equipment assembled on the drilling platform.

Two experienced divers were included in the ship's crew, and these men were available for diving when required. One of the Wimpey boring crew members was also an experienced diver, and his services were utilised on occasions.

For ship to shore communications and general tendering duties, "Ian Salvor III" was served by the 45-ft. sea-going launch "Tug." A small motor launch on board " Ian Salvor III " was used for handling mooring wires.

A retractable platform to accommodate the boring gear and crew was erected on the port side amidships of the boring vessel.

**Preparatory Work**

A considerable amount of preliminary work was required before drilling commenced. Applications had to be made to the Ministry of Transport and Inscription Maritime for permission to put down the boreholes. The Admiralty were responsible for issuing Notices to Mariners, which included continuous broadcast warnings to shipping. Good communications were vital to an operation of the type described in this article. All three vessels used were fitted with radio telephones; " Ian Salvor III " and " Coolcat " were able to make or receive link telephone calls through the normal G.P.O. telephone system. When working off the French coast this was done through Radio Boulogne. The launch " Tug " was able to receive radio telephone messages. Messages were passed to and from the Calais agent by the telex system.

**Mooring the Boring Vessel**

Holding conditions in the chalk sea bed were not good, and tidal currents up to 5 knots were recorded. Consequently, it was necessary to use six heavy anchors to hold the boring craft steady on the borehole position.

To comply with Trinity House requirements two warning light buoys were laid outside the boring craft's moorings at each borehole position. In favourable weather conditions " Ian Salvor III " raised, moved and laid these buoys, each of which was 10-ft. in diameter, 15-ft. high and weighed 5 tons (Fig. 1). On some occasions the buoys were handled by the Trinity House vessel " Ready." Laying the warning buoys was the first operation in moving to a borehole position. Anchor assemblies were then

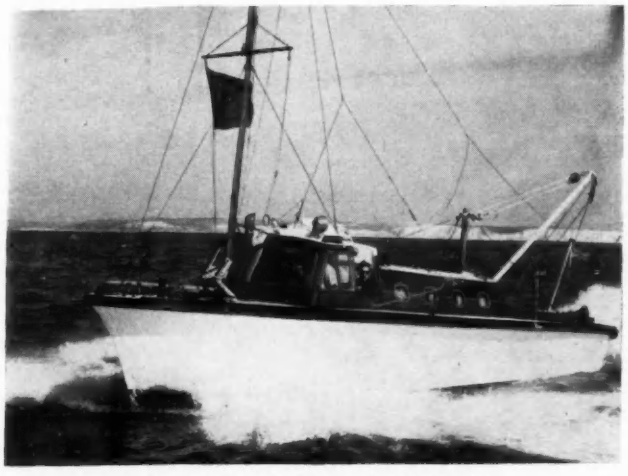


Fig. 5. The 42-ft. launch "Coolcat".

laid by "Ian Salvor III" at appropriate positions, and mooring wires were run out to them from the vessel.

Final adjustment of position was made by warping the ship until the required Decca readings were obtained.

**Setting out the Borehole Positions**

Decca co-ordinates were used by the Channel Tunnel Study Group to define the borehole positions.

After locating the boring vessel at a borehole position by the Decca Navigator, sextant readings were taken to several prominent landmarks when visibility permitted. This gave a more accurate fix of the borehole position.

Most of the borehole positions were fixed accurately by theodolite readings from shore stations. This was done on the English side of the Channel by the Hydrographic Dept. of the Admiralty. L'Institut Geographique Nationale fixed two of the borehole positions off the French coast, also by theodolite readings.

**Boring Operations**

Deep water and strong tidal currents combined with a high tidal range required a carefully worked-out technique for placing, drilling in and supporting the lining tubes. Arrangements had to be made to allow the drilling vessel to be quickly disengaged from the lining tubes on the onset of bad weather, and to enable the partly-drilled borehole to be relocated and boring continued when the vessel returned to the site. These difficult problems were satisfactorily solved, and on several occasions it was necessary to abandon work temporarily on a borehole in periods of rough weather.

The Study Group's interests were mainly in the Lower Chalk layers and the underlying Glauconitic Marl and Gault. Cores 4½-in. in diameter were obtained in these strata. Rotary core drilling methods were used (Fig. 2). Good core recovery, often 100%, was obtained in the Lower Chalk and Gault (Fig. 3).

Selected cores were sealed to preserve their moisture content.

Five boreholes were sunk seaward of Dover, and a further three towards Sangatte, a few miles south of Calais. The deepest hole was sunk to 225-ft. below sea bed level in 123-ft. of water at high water. The greatest depth of water at any borehole position was 155-ft. at high water.

**In-situ Tests in Boreholes**

Two types of in-situ tests were conducted. Electrical logging by means of the Schlumberger portable electric logger (Fig. 4) was undertaken to obtain an indication of the porosity of the Chalk and Gault formations. "Pumping in" permeability tests were also conducted. Two pneumatic packers, at predetermined levels, were inflated to seal off a length of borehole. Water was pumped into the borehole between the packers, and the quantity of water accepted by the chalk in the section under test was measured. The results gave an indication of the permeability of the chalk at different levels in the boreholes.

**SEA BED SAMPLING**

The object of the sea bed sampling programme was to outline and identify the chalk outcrops as accurately as possible, and to provide specimens for palaeontological examination at Imperial College, London. For this purpose a large number of sea bed samples was required from specified locations between Dover and Sangatte.

Specimens were obtained by allowing a gravity sampler to fall freely to the sea bed; the sampler was attached by a wire rope to a winch installed in a vessel.

In the first stages of the programme a sampler weighing 154 lb. was used. A light winch and derrick for handling the sampler was installed in the 42-ft. launch "Coolcat" (Fig. 5). This launch was fitted with Decca navigational aid equipment and an echo sounder. Later in the programme a heavier sampler weighing 700 lb. was used. This sampler was constructed to a design

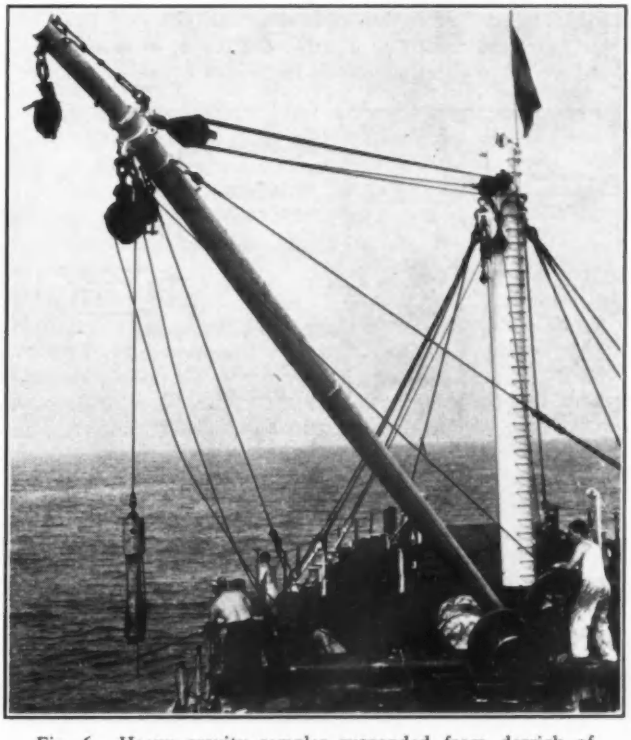


Fig. 6. Heavy gravity sampler suspended from derrick of M.V. "Ian Salvor III".

evolved by the University of Cambridge (Fig. 6), and also used for deep sea sampling by the Institute of Oceanography and Bristol University. A force of several tons was required to extract the sampler from the sea bed; consequently "Ian Salvor III" with its heavy derrick was used for this part of the work.

In both parts of the programme the locations of samples were fixed by Decca readings, sextant check readings being taken when possible. Water depths at sample locations were recorded by echo soundings.

A total of 393 samples was taken, and selected samples were placed in polyethylene bags and sent to Imperial College, London

for micro-palaeontological examination. From this examination it was possible to establish the stratigraphical level of the particular sample by reference to vertical boreholes in which the succession of the various types of foraminifera had previously been determined from examination of core samples. Thus, knowing the stratigraphical level and the location of the sample at the outcrop it was possible for the geological advisers to the Group to deduce the dip of the strata below the sea bed.

### GEOPHYSICAL SURVEY

Geophysical survey methods were used to obtain general information on the structure of the various geological formations across the Channel.

With such a large area to cover, extending from Dover to Folkestone across the Straits to Sangatte—Cap Griz Nez, a rapid means of obtaining the information was essential, and the Continuous Stratification Recorder or "Sparker" was therefore employed. This equipment is basically a form of seismic reflection surveying in which electric discharges of 12,000 volts are fired at the rate of four per second from a spark unit towed behind a launch. The discharge is under water, thus causing a breakdown into hydrogen and oxygen bubbles. These bubbles collapse and cause a continuous series of energy impulses. A hydrophone is towed behind the launch, opposite the spark unit and about 20-ft. from it. It picks up the echoes from the reflecting sea bed strata, and passes them to an analyser and recorder (Fig. 7). The signals obtained are transcribed on a sensitized paper, producing a continuous record or chart similar to that given by an echo sounder.

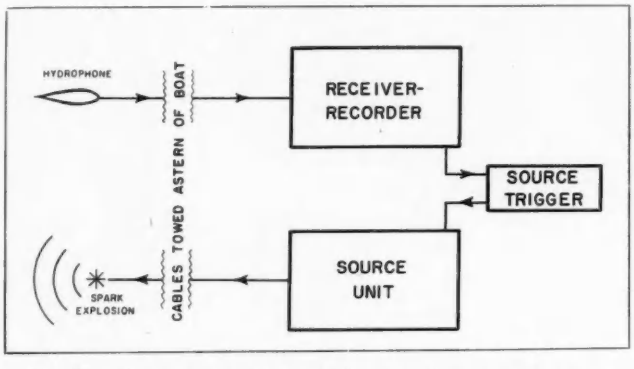



Fig. 7. Diagrams showing "Sparker" equipment and survey procedure.

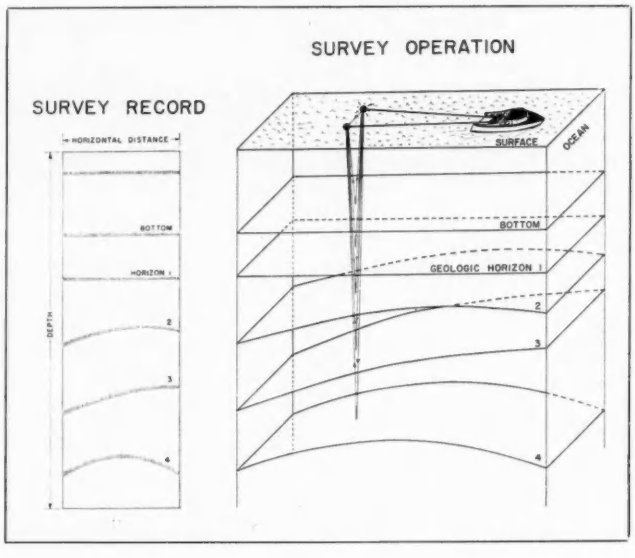


Fig. 8. Propane-Oxygen energy source being hauled aboard launch "Coolcat".

An alternative source of energy is occasionally used. This comprises a mixture of oxygen and propane which is detonated electrically in a small chamber at the end of the towing cable (Fig. 8).

For this work the launch "Coolcat" was used, the towing cables being about 200-ft. long to eliminate propeller noise. Checks at 15 second intervals were made on the track of the launch by Decca readings. During survey work the launch cruised at 5 to 7 knots. When travelling to and from survey locations the speed was about 18 knots. With such high operating speeds, over 50 miles of survey logging were often completed in a day.

This operation proved to be most successful. From the results obtained it was possible to trace the inclinations of the strata from their outcrops at sea bed level to depths of several hundred feet. Thus much valuable information was obtained over a large area.

The "Sparker" equipment was provided and operated by Wimpey's American Associates, Marine Geophysical Services International Inc. of Houston, Texas and Alpine Geophysical Associates, Inc., Norwood, New Jersey. Mr. W. Beckmann of the Alpine Company was responsible for supervision of the Geophysical Survey and for interpretation of the results.

### DOVER HARBOUR LAND BOREHOLE

A borehole was sunk at the foot of the cliffs at the eastern arm of Dover Harbour. This borehole was taken down to the Gault by rotary drilling to a depth of 415-ft. from ground level. Continuous cores were obtained. Electric logging and in-situ permeability tests, as described above, were conducted in this borehole.

*(Concluded at foot of following page.)*

# The Dock and Harbour Authorities' Association

## Abstracts from Annual Report for 1959

In the 40th Annual Report of the Association it is stated that the Treasury has again been approached on the need for further tax relief to port authorities.

The Association also referred to the great need for the modernisation of ports and expressed the view that the port industry has a claim to special consideration. The hope was expressed that the investment allowance would be restored in respect of expenditure on works of port development and improvements.

### Factories Act, 1959

When the Bill for this Act was introduced in October, 1958, the Association raised points on the application of certain provisions in so far as they would apply to dry docks and to ships undergoing repair, and these points were discussed at a meeting held in January with representatives of the Ministry of Labour.

The Ministry were informed that if the clause in the Bill requiring the provision of appropriate means of fighting fire extended to fighting fire on board a ship in a public dry dock, this would place a heavy burden on port authorities who are concerned only as owners of the dock, and technically as occupiers, and who have no control over the actual work of ship-repairing which is carried out by independent contractors.

The Ministry agreed with this view and the Bill was amended so that regulations made under the provisions of the Act in relation to the prevention of fire and fire-fighting equipment may provide that any other person or persons shall be responsible for the contravention, instead of, or as well as, the occupier.

This amendment will enable the Minister to cover the point raised by the Association by a special provision in the Regulations defining responsibility.

The Association also asked that clause 4 of the Bill, which re-enacts section 27 of the Factories Act, 1937, in relation to dangerous fumes, should not apply to a ship in a dry dock. Whilst the Ministry were not prepared to amend the Bill, they agreed that the clause would not be applied to such ships, which would be covered in this respect by the Shipbuilding and Ship-repairing Regulations.

The provisions of the Act relating to the prevention of fire and to fire-fighting equipment have not yet been brought into force. Members will be informed when these provisions come into force and when regulations are made.

### Food Hygiene Regulations

Reference was made in the Annual Report for 1958 to progress made with the Ministry of Health in agreeing a code of food hygiene regulations applicable to dock premises.

During the year, the Ministry of Health consulted the Association on a revised draft of proposals for Food Hygiene Regulations to apply to docks, carriers' premises, public cold stores, wholesale vegetable markets and certain types of storage premises. The revised code is acceptable to the Association subject to certain modifications, which have been suggested to the Ministry. It is hoped that these will be agreed and that the Regulations will be made during 1960.

### Factories Acts 1937 and 1948: Shipbuilding and Ship-repairing Regulations

A further revised draft of the Shipbuilding and Ship-repairing Regulations, issued in April, embodies a number of recommendations for amendment which had been submitted by the Association after considering the previous draft.

In general, the draft is now acceptable to the Association. The Association consider, however, that the proposed obligation to provide fencing at or near the edges of a dry dock should be limited to dangerous places and that, in such cases, the requirement should be amended so that fencing may be provided at, or within a reasonable distance of, the edge of the dry dock.

The Association believe that this proposed obligation may not only interfere with the working of a dry dock, but it may also create danger by the presence of stanchions and chains lying along the edges of the dry dock and along the lengths of altars. The Ministry are not prepared to relax the general requirement, but they have agreed to grant an exemption if any cases of difficulty are proved to their satisfaction.

[As reported elsewhere in this issue, a new statutory draft of the Regulations has now been published and the passages in question dealing with the fencing of dry docks are identical to those published in the April 1959 draft.]

### Rivers (Prevention of Pollution) Act, 1951

Within the last two years there have been a number of applications by river boards under section 6 of the Rivers (Prevention of Pollution) Act, 1951, for orders applying to tidal waters the provisions of sections 2 to 5 and subsections (1) to (15) of section 7 of that Act. There have been similar applications under the Rivers (Prevention of Pollution) (Scotland) Act, 1951.

On the first application, the Association asked that the order should be modified so that the river board would have no control over discharges of oil, which would continue to be dealt with under the Oil in Navigable Waters Act, 1955, and so that the extension to tidal waters would not prevent the use of sanitary appliances on vessels in such waters. It seemed to the Association that, at any rate so far as discharges or escapes of oil were concerned, the matter had already been decided at Government level since the Government are signatories to the International Convention on the Prevention of Pollution of the Sea by Oil, which gives shipowners and masters of ships certain defences to proceedings taken against them under that Act. These defences would not be open where a prosecution was taken under the appropriate Rivers (Prevention of Pollution) Act and, since the Government have ratified the International Convention, foreign shipowners and masters of ships are entitled to expect that the agreed defences would be open to them in this country. Unfortunately, the Ministry of Housing and Local Government would not at first agree the proposed modification and it was necessary for the Association to be represented, together with the Chamber of Shipping, at two Inquiries, one in relation to the Firth of Forth (Prevention of Pollution) (Tidal Waters) Order and the other in relation to the Milford Haven and River Dau Cleddau (Prevention

# The Channel Tunnel Project

(*Continued from previous page*)

### Laboratory Investigations

Triaxial compression tests were made on selected cores of the Lower Chalk at lateral pressures up to 1,000 lb./sq.in. to determine the cohesion and angle of shearing resistance of this material. The micro-palaeontological examination of the sea bed and borehole specimens was carried out by Mr. D. J. Carter at the Imperial College of Science and Technology in London.

### Acknowledgments

The work described in this article was undertaken for the Channel Tunnel Study Group. The Group are represented in Paris by M. Rene Malcor, Chef Ingenieur des Ponts et Chaussees; and by Mr. H. J. B. Harding, B.Sc., M.I.C.E., consulting engineer, in London. Professor J. M. Bruckshaw of Imperial College is the consulting geophysicist to the Group. The Authors are indebted to the Group for permission to publish this article.

with the Ministry of Housing and Local Government it has now been agreed that, unless there are some exceptional circumstances, the modifications for which the Association have asked will be included in all future orders.

**Model Code of Petroleum Spirit Byelaws**

Consideration has been given during the year to the amendment of the Model Code of Petroleum Spirit Byelaws and it is hoped that the new Model will be available early in 1960.

The Association consider that the Byelaws should extend to all operations where gas may be present and they are pleased to report that the new Model Code will cover the operations of gas-freeing and tank cleaning, as well as loading and discharging and also any acts of ullaging, sounding or sampling, whether or not carried out in connection with the loading or discharging of petroleum spirit.

The present Model Byelaws require all the pipelines and hoses to be adequately and continuously earthed during loading and discharging and the Association have asked that in the new Model there should also be a requirement that, prior to any connection of the pipeline or hoses with the shore, the petroleum ship should be adequately earthed independently of the earthing of the pipeline and hoses, and that the ship should remain continuously earthed until such time as the pipeline or hose connections have been broken. This is already a jetty requirement of the principal petroleum companies.

**Damage to Dock Works**

This matter has received further consideration during the year and, as a result, the Association believe that it should be possible to reduce the number of cases of damage to dock works by fitting in vessels some warning or obviating device to prevent or minimise damage caused in two ways, namely:

(a) by a failure in controlling machinery ; and

(b) by the incorrect interpretation of bridge telegraph orders.

The latter is the more common cause of damage and is probably the one more easily solved.

The Committee appreciate that there is a difference of technical opinion as to the best way of solving these problems, and they have therefore suggested to the Chamber of Shipping, the Liverpool Steam Ship Owners' Association and the British Tugowners' Association that these bodies should now consider, with their technical advisers, the best methods of overcoming these two problems with a view to making recommendations to Lloyd's Register of Shipping and the other Classification Societies.

The Committee desire to stress once again the great importance of this matter. Resultant damage may extend far beyond the actual damage to the dock works involved in any collision, indeed, a whole dock system could easily be put out of action for some weeks as a result of comparatively minor damage to dock works. The problem is therefore one with which shipowners are vitally concerned and the Committee hope that recommendations will be made to the Classification Societies during 1960.

**Pollution of the Sea by Oil**

In 1952, prior to the International Conference on the Pollution of the Sea by Oil, Mr. L. J. Callaghan, M.P., set up an unofficial Advisory Committee on Oil Pollution of the Sea. This Committee is composed mainly of representatives of County and Local Authority Associations, the Chamber of Shipping, the River Boards' Association, the Councils for the Preservation of Rural England and for the Preservation of Rural Wales, and Societies concerned with fauna preservation and bird protection.

Similar unofficial organisations exist in other countries and a second international conference of representatives of these organisations was held in Copenhagen in July to discuss how far the 1954 Convention on the Prevention of Pollution of the Sea by Oil has been effective in decreasing the contamination of coasts and beaches and the destruction of bird life.

The Association were invited by Mr. Callaghan to be represented at the Conference and Mr. Arnet Robinson and the Secretary attended. Mr. Arnet Robinson submitted to the Conference a Paper entitled " The Convention as it affects British Ports," in which he expressed the interest of the Association in the prevention of pollution and their support for any measures adopted for this purpose, drew attention to the action taken by port authorities to detect oil pollution offences in harbours, and dealt with the steps being taken by them to provide oil reception facilities. In this connection, Mr. Arnet Robinson referred to the fact that, whilst British dry cargo ships which use their bunker tanks for ballast water, are required to be fitted with efficient separators, there is at the present time no corresponding requirement in respect of the ships of other countries. Under the Oil in Navigable Waters Act, 1955, a port authority is only required to provide facilities to take treated ballast water, that is to say, ballast water which has been subjected to an effective process for separating the oil from the water. Mr. Arnet Robinson said that it would be almost impossible for port authorities to provide facilities for large quantities of untreated water and he expressed the hope that foreign ships would be fitted with an effective process for separation.

The Conference passed a Resolution calling for a further Diplomatic Conference as soon as possible, with a view to achieving the aim of total avoidance of the discharge of persistent oils into the sea.

**Permanent International Association of Navigation Congresses**

At the XIXth Congress of the Permanent International Association of Navigation Congresses held in London in July, 1957, a discussion took place on the measures being taken for improving the handling of general cargo between the vessel and the storage installations on the quay or between the vessel and the means of inland transport. As a result of this discussion it was considered that there is need to ensure, on an international basis, the continuous exchange of information in relation to cargo handling.

It has now been decided to set up an International Committee to study, in conjunction with other appropriate organisations, where desirable:

(a) the provision and full utilisation of terminal facilities and appliances to ensure the speedy and economical flow of cargo ;

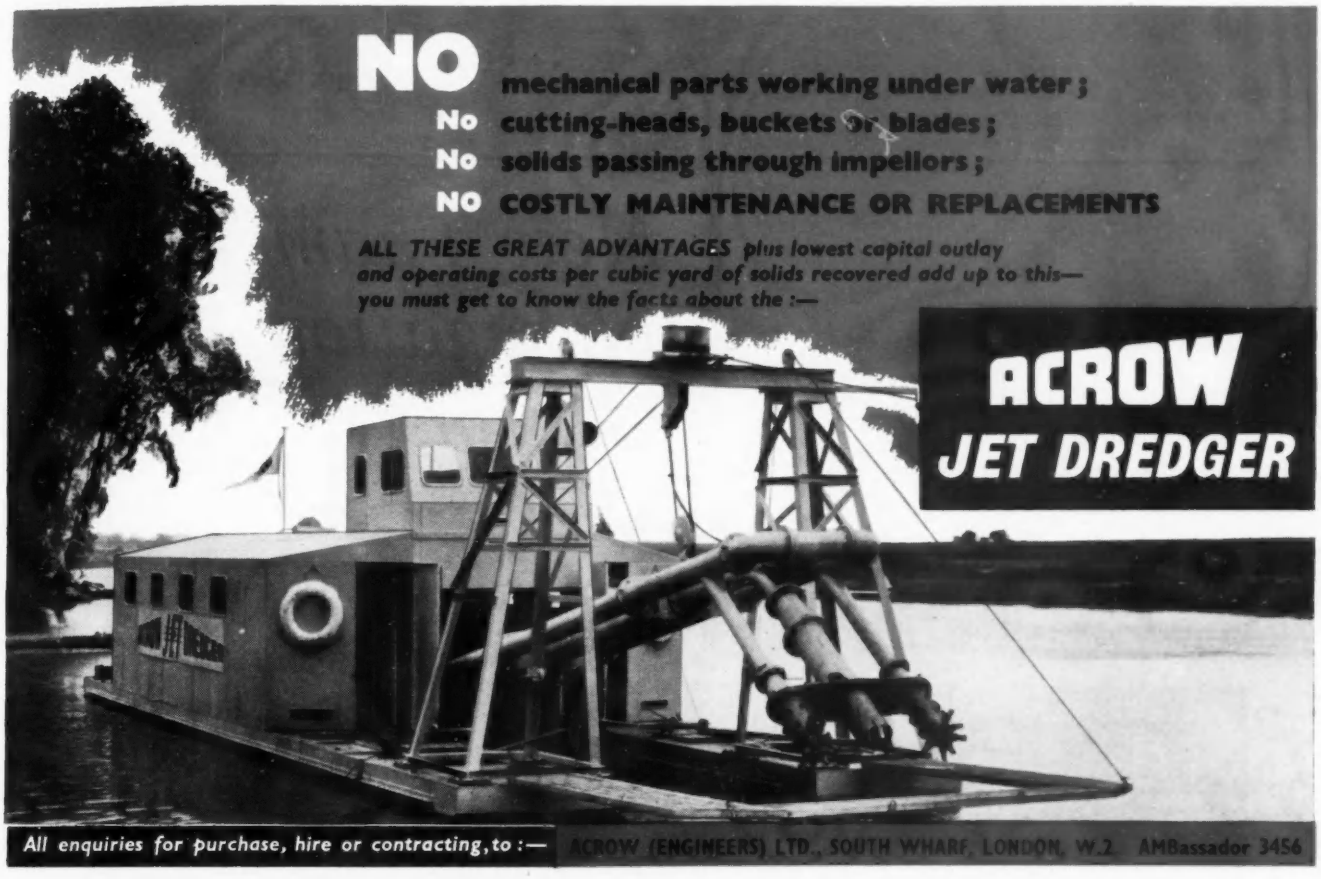
(b) improved methods of presenting general cargo for shipment by utilisation of existing and new techniques so that such cargo is made available in the most economical number of units ;

(c) the principles governing the design of ships and conveyances with terminal facilities and methods of presenting cargo ; and

(d) the problems relating to the marketing and packaging of individual items of cargo.

The British National Committee set up a Working Party to advise on the implementation of the recommendations and a British Committee has been set up.

The Association welcome this development and they will be represented on the British Committee by Mr. R. H. Butler, Senior Traffic Officer to the Port of London Authority. Mr. J. D. J. Saner, Engineer-in-Chief to the Mersey Docks and Harbour Board, will also serve on the Committee as the representative of the Dock and Harbour Engineering Joint Committee.


NO mechanical parts working under water;
No cutting-heads, buckets or blades;
No solids passing through impellors;
NO COSTLY MAINTENANCE OR REPLACEMENTS
ALL THESE GREAT ADVANTAGES plus lowest capital outlay and operating costs per cubic yard of solids recovered add up to this— you must get to know the facts about the :—
ACROW JET DREDGER
All enquiries for purchase, hire or contracting, to :— ACROW (ENGINEERS) LTD., SOUTH WHARF, LONDON, W.2. AMBassador 3456

# Aden Port Development

*Employing Authority: Aden Port Trust*
*Consulting Engineers: Sir Bruce White, Wolfe Barry & Partners*

*Aerial view of completed works, showing new import quay. subsidiary quays, reclamation work, new warehouse sheds and roads.*

## PAULING & CO. LTD.

*ASSOCIATED COMPANY*

**RUSH & TOMPKINS, LTD.**

CIVIL ENGINEERING AND BUILDING CONTRACTORS

26 VICTORIA STREET, LONDON, S.W.1

LONDON · DURBAN · ADEN · ALBERTA · BRITISH GUIANA · SIERRA LEONE

# *New Thames Navigation Scheme*

PYE

RADIOTELEPHONES CHOSEN FOR INTERNATIONAL VHF SCHEME

The most comprehensive radiotelephone system in the history of Thames shipping has been inaugurated. For the first time complete radiotelephone coverage is provided for the whole of the Port of London Authority area from London Bridge to ten miles east of the Nore. The Pye v.h.f. radiotelephone installation has been designed to international specifications to enable ships of all nations to make use of this valuable and timely service.

Among the shipping lines that are already having their ships fitted with the corresponding Pye frequency modulated v.h.f. radiotelephone equipment are:

*Dover Harbour Board.*

*Townsend Bros. Ferries.*

*Ministry of Transport—British Railways (S. Region).*

*Trinity House Pilotage Dept.*

*Esso Petroleum Co. Ltd.*

*Societe Maritime Belge.*

*Union Castle Line.*

*William Cory & Sons.*

*British & Commonwealth Shipping.*

*Prince Line.*

*50 ships of a Belgian Fleet and 48 vessels of the Royal Netherlands Navy also fitted.*

*And many other users.*

PYE TELECOMMUNICATIONS LIMITED · NEWMARKET ROAD · CAMBRIDGE · ENGLAND

# Correspondence

*To The Editor of the Dock and Harbour Authority*

Sir,

**Administration of Terminal Facilities for Overseas Trade**

I found it a trifle disconcerting that R. B. Oram in his letter in your January issue, found it necessary to clarify the fact that the ship or shipper does not dump cargo **on** the ship's rail for delivery or acceptance.

It may be of some help to expound on this matter if for no other reason than the benefit of student readers.

The term "**at** the ship's rail" is well worn and should perhaps have faded out by now. But nevertheless it is still customarily used.

Custody of cargo discharged or loaded by a ship must necessarily at some stage change hands. This may be at varying points. If discharge is effected into a shed owned or leased by a shipowner, the cargo is still with the owner, although no doubt a tally of the ship's discharge will be made for record purposes. If however, the ship discharges cargo direct into the custody of a port authority or warehouseman, there must necessarily be a point during this process where custody changes hands, and is presumably the most convenient place nearest to the ship's purchase as possible. It is at this point that the discharge or shipment should be recorded by tally.

R.B. Oram quotes the definition by L. J. Lord Dundas in Dampskibsselskabet Svendborg v. Love and Stewart.

"One must distinguish between the operation of discharge and the disposal of the cargo, when discharged, by the consignee. Discharge begins and ends as from the ship on to the quay or on to such appliances . . . . as are customary at the port of discharge."

Admittedly the ship's rail plays no physical part in the process of discharge or loading, but it is a term used to imply that it is a point within a limited vicinity where the operation is terminated or commenced.

Yours faithfully,
W. H. LAIT.

1-5 Broad St. Place,
London, E.C.2.
2nd February, 1960.

---

*To The Editor of the Dock and Harbour Authority*

Dear Sir,

**Documentation at Ports**

I believe your journal has performed a service to the port industry by emphasising the problem which documentation at present causes, particularly in the sphere of exports.

There is no doubt that the extreme congestion caused by the concentration of deliveries of cargo to the berth during the last day or two the ship is loading, is increased by the complexity of the documentary work. Although dock authorities are nearly always blamed for the confusion and delay which result from this congestion, the remedy is not in their hands. Cargo Superintendents and Master Stevedores suffer with the rest, the latter because their selection of cargo for shipment is hindered partly by the late arrival of so many consignments and partly by the restrictions which arise from the volume and variety of documents.

Shipping Companies will seldom take any important remedial action for fear of upsetting their customers and driving them to their competitors. It would seem, therefore, that co-operation is needed between even rival interests, so that effective action can be taken to ensure a more even flow of export traffic to the docks and to achieve a much needed reduction in the types and quantity of documents required. In the editorial columns of your last issue, you concluded by stating that there was immediate need to find an influential body to take the initiative in this matter of document simplification. I am sure that many dock operating interests feel that the effort you are making will assist towards the end in view.

London, E.16.
2nd February, 1960

Yours faithfully,
CARGO SUPERINTENDENT

---

*To The Editor of The Dock & Harbour Authority*

Sir,

**Simplification of Shipping Documents**

I have read with interest the articles, and editorial comments relevant to the above subject, which have appeared in recent issues of your Journal.

All those involved in some measure or form in shipping documents will give support to the desire to simplify the existing maze. The extent of the requirements of Port Authorities will naturally vary in view of the differences existing in the range of functions undertaken but the unity of purpose is quite clear. Certainly it is well worth trying to find out how far the various interests concerned can join in an investigation with the object of "unification and simplification." This need not be a mere catch phrase.

Yours faithfully,
A. S. MOUNTFIELD,
General Manager and Secretary.

Mersey Docks and Harbour Board,
Dock Office, Liverpool 3.
9th February, 1960

# Shipyard Safety

## Statutory Draft of New Regulations

The Minister of Labour has published a statutory draft of a new code of special regulations to replace the Shipbuilding Regulations, 1931. The draft regulations relate to repair and construction work carried out in harbours and wet docks (which is not subject to the 1931 regulations) as well as in shipyards and dry docks.

The purpose of the regulations, the Ministry of Labour states, is to safeguard the health and promote the safety and welfare of persons employed in the shipbuilding and shiprepairing industries. Among the new provisions in the draft regulations are requirements as to the fencing of dry docks, guard rails on staging and precautions to be taken against explosions and fires on oil-carrying vessels. Provision is also made for the allocation of responsibility for the observance of the regulations.

Earlier drafts of the regulations were published in August, 1950, May, 1958, and April, 1959, and were the subject of correspondence and discussions between the Ministry and the interested organisations, among which were the Shipbuilding Employers' Federation and the Confederation of Shipbuilding and Engineering Unions.

About half the regulations in the draft have been amended. Most of the amendments are in point of detail, and many have been exemplified or clarified.

The publication of the statutory draft provides an opportunity for those concerned to examine the requirements and consider whether they wish to object to any of them. Every objection must be in writing and state the specific grounds of objection and the omissions, additions or modifications asked for. Objections may be addressed to the Secretary, Ministry of Labour, 8, St. James's Square, London, S.W.1, and must be sent not later than March 21, 1960.

The statutory draft—Shipbuilding and Shiprepairing Regulations, 1960—is obtainable from H.M. Stationery Office or any bookseller, price 1s. 5d. post free.

# Manufacturers' Announcements

## New Hobart Bridge

The Tasmanian Government has recently awarded the contract for the construction of a prestressed concrete road bridge over the River Derwent at Hobart, Tasmania to two British civil engineering companies, Reed & Mallik Ltd. of Salisbury and Braithwaite & Co. Engineers Ltd., London. The value of the contract is in the region of £A4¼ million. The bridge was designed by the Consulting Engineers, G. Maunsell & Partners of London and Melbourne. The period of the contract will be three years and work is expected to start early this year.

The bridge which is to be sited immediately south of the existing floating arch bridge it is to replace, will be a multi-span structure in reinforced and prestressed concrete, 3,364-ft. long between main abutments, with approach spans totalling 425-ft. on the west side and 840-ft. on the east side. The carriageway is 44-ft. wide flanked by two footways each 4-ft. 6-ins. wide.

The main navigation span is 310-ft. long and gives a clear height of 150-ft. above water level over a width of 180-ft. This span is made up of a suspended section supported on cantilevers which extend from the adjacent 197-ft. navigation spans. The remainder of the bridge between the abutments is composed of 140-ft. spans, there being 13 on the west side and 6 on the east side of the navigation spans. Expansion joints are provided on either side of the 3 navigation spans: at all other bridge supports the spans are continuous as far as the main abutments.

The bridge deck is composed of 6 precast prestressed concrete beams with an insitu reinforced concrete slab. Reinforced concrete diaphragms are provided at the supports which are slender concrete columns mounted on cast insitu piers with precast concrete skirting at water level. Each pier is supported on a group of vertical and raking bored piles of reinforced concrete, 4-ft. 6-in. diameter, which are to penetrate the alluvial deposits on the river bed down to the underlying rock stratum. The maximum depth of water in the estuary is approximately 120-ft.

The main western abutment is located in shallow water and is a massive reinforced concrete structure founded on rock. To the west of this abutment the approaches comprise a number of comparatively short spans in precast and prestressed concrete on reinforced concrete piers founded on rock, arranged to form a series of flyover crossings. The eastern abutment is a similar massive concrete structure but is located on the river bank where rock occurs at a shallow depth. The eastern approaches comprise 12 spans each 70-ft. in length in reinforced and prestressed concrete, supporting a carriageway and footpaths of similar dimensions to those on the main structure

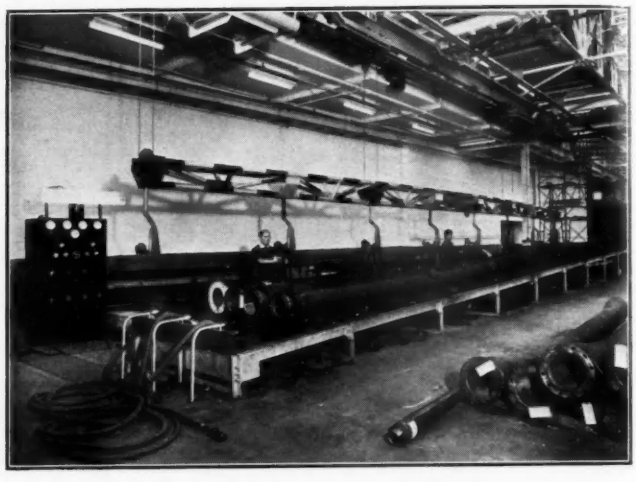
The superstructure will be asembled on specially designed steel staging, supported on the piers and moved from one position to the next on pontoons. The bored piles will be guided and positioned by floating steel templates anchored to the river bed, which will also form the shuttering for the insitu pile caps.

## New Hose Plant at Castle Mills, Edinburgh

Lord Craigton, Minister of State for Scotland and Sir Ian A. Johnson-Gilbert, Lord Provost of Edinburgh, recently visited the Castle Mills factory of the North British Rubber Co. Ltd. to view the new Hose Plant, which is the main feature of the company's £3 million modernisation scheme. This programme also included doubling the capacity of the Tyre plant, erecting a new central steam plant and improving the remaining facilities. All this work has now been completed.

The new Hose plant, extending over some 7½ acres, is situated to the extreme west of the main factory block and at present comprises a single storey building of two 70-ft. bays, each 600-ft. in length. A further bay can be added in the future which would increase the production area by 50 per cent. The new layout represents a straight line flow from rubber and fabric storage to cleaners and extruders, fabric cutting, braiders, vulcanisers, inspection and despatch departments. The plant is serviced by a series of 60-ft. radius overhead cranes, so that operatives do not have to manhandle the hose at any stage of its manufacture. Particular attention has been paid to the hydraulic testing equipment for heavy hose, which is very important in the case of oil and rotary drill hose.

The manufacture of hose has always been one of the main products of this Company and in the past ten years outstanding



View of Oil Hose test area, with hose being mounted on test tank.

progress has been made in the production of giant oil hose, 90 per cent of which is exported to tanker, quayside and submarine installations in the Middle and Far East, South America and the East Indies. The new equipment now installed will enable the Company to concentrate on braided hose, features of which are lightness and flexibility. Certain lines of wire braided hose required for hydraulic equipment, aircraft and motor fuelling, and high pressure greasing are made to withstand pressures of 5,000—6,000 lbs. per sq. in. Many of the new hoses being manufactured are made from synthetic rubber and are resistant to oils and chemicals.

## Cast Iron Plates

The new Stelcon Cast Iron Plate utilises all the fine qualities of cast iron, a traditional and proved flooring material, and eradicates many of its disadvantages. Cast iron "lasts for ever" and this is a good reason for applying modern techniques of metallurgy and casting to produce a cast iron plate designed to give the best possible service during many years of life.

A high quality casting, free from any casting defects, was the first requirement. Accuracy had to be to very severe limits to give the exact fit required to make a satisfactory floor. Modern techniques and skills, checked by careful inspection, achieved these basic aims, while permitting the use of a desirably low phosphorus iron which combined toughness with wear resistance.

The surface pattern is designed to overcome slipperiness without introducing noise. Because of the fine finish of the casting the sharp edges of the groove retain non slip qualities throughout the life of the plate, at the same time the fairly shallow grooves are easy to clean.

The design has features which ensure a firm bedding, overcoming a very prevalent difficulty in the laying of cast iron floors.

Practical trials have encouraged Stelcon (Industrial Floors) Ltd. to believe that this new plate will render an important service to industry.

## Monotower Cranes for Greenock Dockyard

The Greenock Dockyard Co. Ltd. have installed four "Butters" travelling monotower cranes to serve their recently modernised building slipways. This type of crane has certain advantages over the older type cantilever crane in that its relatively light luffing jib is easily operated and presents a very much reduced area to the wind, thus assisting continued work in high winds. Also with the luffing jib heel pin set at a level to suit the height of ship being constructed in the slipways, the desired height of lift and clearance can be easily attained without a high supporting tower. This has a beneficial effect in reducing the wheel loads, thereby reducing the cost of piling and reinforced concrete work in the crane tracks.

These four cranes have a maximum lifting capacity of 25 tons, lifting at a radius of 90-ft. (measured from the track centre) to a minimum radius of 30-ft. The main hook lifts loads up to 20 tons at 100-ft. radius and 10 tons at 122-ft. radius. The cranes are fitted with an auxiliary lift which handles loads weighing up to 3 tons at a maximum radius of 130-ft., jig length 125-ft., at a speed of 150-ft. per minute. This is driven by a 45 h.p. motor. The main hoist is operated by a 60 h.p. motor and arranged to give two speeds of lift: loads up to 25 tons at 23-ft. per minute, 8 tons at 70-ft. per minute. The lift is on a single pulley return block fitted with a safety type hook mounted on a ball bearing swivel.

One of the monotower cranes installed at Greenock Dockyard.

The luffing motion is driven by a single 40 h.p. motor, giving a speed of 40-ft. per minute with a full load of 25 tons. A 35 h.p. motor drives the slewing gear, developing speed of 250-ft. per minute at 90-ft. radius with the maximum rated load suspended.

Travelling on a double rail track set at 30-ft. centres with a 16-ft. high portal opening at the foot of the 75-ft. high tower, the crane is mounted on 16 centre flanged rail wheels, eight of which are driven in pairs by four 16 h.p. motors developing a geared travel speed of 50-ft./min. All motions of the crane are controlled from the operator's platform at the front of the revolving portion of the crane and above the tower top level. All the motors are totally enclosed, half hour rated, slipring reversing, crane type, capable of exerting a starting torque of 200% full load torque with a starting current of 250% full load current, an overload capacity of 100% in torque for 30 seconds and have a temperature rise not exceeding 50°C.

A crane protective panel is fitted within the operator's cabin, and each motion is controlled by a separate air break drum type reversing controller. The main hoist, luff and travel motions are fitted with electro-hydraulic brakes.

Current supply to the crane is collected from a socket (position at middle of crane travel) by means of a 4-pin plug attached to a 4-core T.R.S. flexible trailing cable coiled on the cable drum. A limit switch is fitted to the drum to protect the cable against over-travel of the crane.

## Shunting Locomotives for B.T.C.

The British Transport Commission has placed an order with Yorkshire Engine Company, Ltd., Sheffield, a subsidiary of The United Steel Companies Ltd., for the supply of ten 170 h.p. diesel-hydraulic shunting locomotives. The locomotives will be delivered during 1960 and will be used on the London Midland region of British Railways, principally in the Manchester and Liverpool dock areas.

The 170 h.p. diesel-hydraulic locomotive has been developed in collaboration with Rolls-Royce and it is fitted with their engine and torque converter. Its main characteristics are a simplified layout of power equipment, involving no change of gear or jack shaft as the three-stage converter provides a speed range of 0 to 18 m.p.h.; comparatively short overall length; and a small and narrow bonnet, giving extremely good visibility to the driver.

## Electronic Computer for Hydraulic Calculators

An electronic computer, the National Elliott 802, is being used to solve complex scientific and engineering problems at the Hydraulic Laboratories of the Belgian Ministry of Public Works, Antwerp.

The machine, which was supplied by the National Cash Register Co. Ltd., London, N.W.1, and has begun to perform a long series of calculations concerned with navigation conditions on the River Scheldt, Belgium's main waterway. Later, the machine will undertake similar work in connection with the planning of large dams and electric power plants for the Site d'Inga on the Belgian Congo.

These computations will provide important information about the problems of tides, currents, sandbanks, etc.

## Onazote for Boom Defence

After nearly 20 years' total immersion in sea water, Onazote slabs, which were used to provide buoyancy in baulks used for boom defence in the last war, have been found to be in perfect condition. Each baulk, measuring approximately 10-ft. x 6-ft. x 4-ft., was made of timber and packed tight with Onazote slabs. The baulks were then joined together by short lengths of steel chain. These boom defences guarded harbours and approaches in Britain and originally the baulks were filled with solid wood which, however, eventually became waterlogged. Onazote was therefore tested and after successful trials became one of the more important standard materials used for boom defences.

About 250 baulks were purchased recently by B.R.T. Securities Ltd., a firm of salvage specialists. Most of them had been made in 1940 and when they were opened recently, the Onazote slabs inside were found to be in mint condition apart from a little dirt and, in some cases, being covered with some marine growth.

Onazote, a product of Expanded Rubber Co. Ltd., Mitcham Road, Croydon, is an expanded ebonite material with a non-intercommunicating cellular structure. It has greater buoyancy for its weight than any other known material.

## Simons-Lobnitz Ltd.

The two well-known Dredger Specialists, Shipbuilders and Engineers of Renfrew, Scotland, Messrs. Simons and Company Limited and Lobnitz and Company Limited, merged their interests on 31st December 1959, and will now trade as one company to be known as Simons-Lobnitz Limited. The Management personnel of the two former companies will continue to be available in the combined concern.

## L.P. Gas for Industrial Trucks

Lower running costs, reduced maintenance, freedom from noxious odours and, in some instances, higher efficiency, have led to a widespread interest in liquefied petroleum gases as a fuel for industrial trucks and other mechanical handling equipment. As the result of co-operation between the manufacturers and technical experts of Shell-Mex and B.P. Gases, Ltd., the products Bottogas (butane) and Propagas (propane) are now available in, among others, Coventry Climax, Stacatruc and Hyster fork-lift trucks, as well as in such diversified items as mechanical stackers, wagon shunters and power floor sweepers. Shell-Mex and B.P. Gases maintains a distribution service throughout the United Kingdom from 10 main centres. Bottogas is sold generally in 40-lb. containers and is the fuel for larger engines, including those in fork-lift trucks, while Propagas is supplied in 10-lb. or 24-lb. containers and is suitable for smaller engines. For use in bulk there is a 1,600-lb. spherical container and dispenser unit. A 40-lb container will suffice for 10 to 16 hours of continuous operation of a fork truck, according to its capacity.

L.p.g.-fuelled engines have the great merit that they can be used in small, enclosed areas and are bringing back to favour the internal combustion (petrol) engine, which is undeniably quieter than the diesel.

A tested and approved conversion kit is manufactured by the Lipton L.P. Carburetter Co. Ltd. of Wooburn Green, Bucks. It comprises a regulator-vaporiser unit, vaporisation being effected by means of a heat exchanger connected to the engine. Gas is metered out according to the demands of the carburetter. This is the model Xg, incorporating an economiser varying the mixture to the engine load and an easy starting feature consisting of a separate set of gas-air orifices. A fuel filter and automatic shut-off valve (diaphragm actuated by engine manifold vacuum) completes the conversion. The diaphragms opens the valve when the engine is turned over and closes it when the engine is stopped.

## Aluminium Alloy Launch for Lake Tanganyika

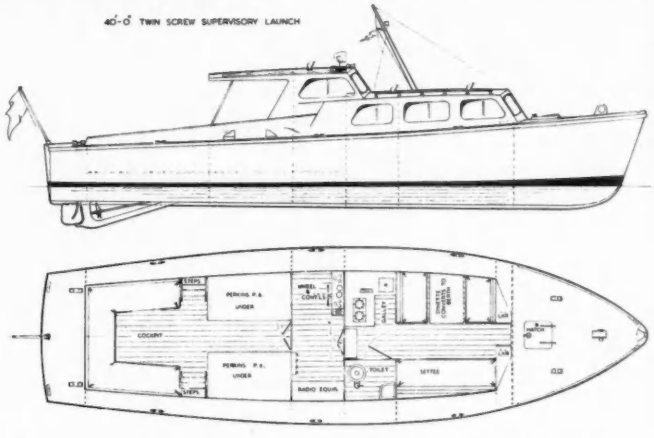
An aluminium alloy survey and patrol launch, recently designed and built for the Belgian Government by Universal Shipyards (Solent) Ltd. for service on Lake Tanganyika, is based on their standard Two-Way Tension system. The overall length of the craft is 40-ft., with a beam of 11-ft. 6-in., and a draught of 2-ft. 9-in.

The hull which is of rivetted construction is made of aluminium alloy supplied by The British Aluminium Company Limited. This material was chosen because marine borers, wet or dry rot and other forms of deterioration which are found in a tropical climate would wreak havoc on a wooden hull and steel is too heavy, for the speed, performance required, and draught needed in shallow waters.

A normal cruising speed of 12 knots with a maximum of 15 knots is comfortably achieved with the Twin Perkins P.6 diesel engines each developing 65 h.p. at 2,000 r.p.m.

The launch has been arranged to provide comfortable accommodation. The saloon is spacious with large forward and side windows. On the port side there is a dinette arrangement, convertible to a double berth, and, on the starboard side, there is a full length settee convertible to two single berths. On the port side, at the after end of the saloon, is a small galley with a paraffin cooker, stainless steel sink and electric refrigerator and on the starboard side, a toilet compartment fitted with W.C. and wash basin.

There is an enclosed wheelhouse aft of the saloon, with the steering position on the port side, and space for radio equipment




on the starboard side. All the engine controls and instruments are conveniently grouped together in front of the helmsman.

The aluminium alloy wheelhouse roof, is extended aft over the engine cases, which are of timber construction lined with glass-fibre sound insulating material. Aft, of the engine cases, there are port and starboard boarding steps, and a large open cockpit with seating accommodation arranged around the after end.

The two welded aluminium alloy fuel tanks, each with a capacity of 100 gallons, are installed in the stern under the after seats. Right forward, there is a large bosun's store, separated from the saloon by a water tight bulkhead.

## Commercial Development of Dracones

The Dracone, a flexible sea-going container for the carriage of oil and other liquids, which was first developed four years ago by a group of Cambridge scientists, is to be launched commercially throughout the world by a new company Dracone Operations Ltd. The new company is sponsored mainly by associates of Hambros Bank, and of H. Clarkson and Company, ship brokers. Dracone Operations Ltd. is also associated with Dracone Developments Ltd., an off-shoot of the Government sponsored National Research Development Corporation which co-operated in the development of this new type of container.

**SVENSKA ENTREPRENAD AB SENTAB**

***Consulting Engineers and Supervisors, Stockholm***

**has the following Vacancy in West Africa**

**Supervision Engineer.**—Civil Engineer with considerable maritime experience to assist the Resident Engineer in supervising the contract for the construction of an open-sea harbour on the coast of West Africa. Preferred age about 40. Salary up to £3,000 p.a.

Written application full details of experience and qualifications should be addressed to

"Department 5102," Svenska Entreprenad AB, SENTAB, Villagatan 6, Stockholm Ö, SWEDEN.